Emergency diesel sets
All relevant routine and type tests according to:

ISO	3046	Reciprocating internal combustion engines - Performance
ISO	8528	Generating sets with reciprocrating internal combustion engines

a) Type tests
The diesel generator unit (DGU) and all auxiliary equipment shall be fully type tested. These tests shall include all type tests as defined in the relevant latest IEC and ISO recommendation (as a minimum requirement).

Evidence shall be given that the DGU together with the auxiliary equipment to be provided, under these specifications, have successfully passed all type tests of design, service frequency, impulse, insulation level, dynamic operating range, and electrical and mechanical endurance performance, as appropriate and as specified.

However, if deemed necessary, the Employer shall decide if additional tests are required to be performed by the Tenderer/Contractor.

The Tenderer/Contractor shall supply certified copies of type test certificates covering the proposed DGU of similar capacity or higher, operating range, data features, design and construction.

b) Sample tests
Sample Tests shall be performed, comprising as a minimum the following tests:

- Visual checks and measurements of dimensions
- Functional tests.

c) Routine tests
The Tenderer/ Contractor is required to carry out routine tests on each assembled and finished diesel generator unit and its relevant auxiliary equipment to demonstrate the integrity of the system.

Routine test certificates shall be submitted for the Employer's review and approval before shipment of the DGU.

The DGU shall pass all the routine tests as laid down in the relevant latest revisions of IEC & ISO Standards. In addition, the visual Inspection, which shall determine conformity of the DGU & the relevant equipment with the requirement, shall be part of the routine tests.

The acceptance test for the diesel engine at the Manufacturer's workshop test bed shall include the measurements, calculations and functional checks stated in ISO 3046-1 (E).

A test report in English shall be issued according to ISO 3046-1 (E) giving evidence of the following data:

- Engine model, order No., rated output, operating speed, number of cylinders, bore, stroke, compression ratio, cylinder displacement, no. of strokes, date of test, the Employer's name, inspector's name, ambient air temperature, relative humidity, barometric pressure, fuel specific gravity, fuel net calorific value, setting data of injection pump, firing sequence, valve timings, type of fuel oil filter, type of lube oil filter, type of turbocharger and inter-cooler, type of governor, type of injectors.

The Tenderer/Contractor shall submit together with the test report a certificate showing the emission levels of the exhaust gases: NOx, CO and PM (particulate matter).

The diesel engine shall be proven to be capable of operating in steady state condition on all above mentioned loads. If the diesel engine fails to operate in steady state condition on one or more loads, this engine type shall be not accepted for the scope of the diesel generator units.

d) Special tests
The diesel engine shall be at least tested in total for one hour at the following loads:

• Warm-up of the diesel engine	as required
• 25 % load operation	10 minutes
• 50 % load operation	10 minutes
• 75 % load operation	10 minutes
• Full load operation	20 minutes
• 110 % load operation	20 minutes
• Cool down of the diesel engine.	

During the test run, temperatures, pressures and fuel consumption shall be measured and recorded.

The diesel engine shall be proven to be capable for operation in steady state condition on all above mentioned loads. If the diesel engine fails to operate in steady state condition on one or more loads, this engine type shall not be accepted.

Low voltage switchgear
The following standards and regulations or equivalent shall be used:

IEC 60947	Low-voltage switchgear and control gear
IEC 61439	Low-voltage switchgear and control gear assemblies
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60898	Specifications for circuit-breakers

IEC	60079	Electrical apparatus for potentially explosive atmospheres
IEC	60947	Regulations for low-voltage switchgear

The "Design Verification" of all low voltage switchgears/ motor control centers shall be carried out by following methods:

- "Testing" for the Pos. No. 1., 2., 3., 4., 5., 9., 10., 11., 12. and 13 of IEC 61439-1/Annex D, Table D.1
- "Assessment" for the Pos. No. 6., 7. and 8 of IEC 61439-1/Annex D, Table D.1

In addition to the above tests for which certificates shall be submitted, at least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests at main circuit
- Dielectric tests of the auxiliary and control circuits
- Functional test of the control circuits
- Check of the operational sequence.

Capacitors

IEC	60831	Shunt power capacitors
IEC	60871	Shunt capacitors for A.C. power systems
IEC	60931	Shunt power capacitors
IEC	60143	Series capacitors for power systems
IEC	60358	Coupling capacitors and capacitor dividers
IEC	60384	Fixed capacitors for use in electronic equipment

Batteries, charging equipment inverters and DC/DC converters

IEC	60086	Primary batteries
IEC	60119	Recommendations for polycrystalline semiconductor rectifier stacks and equipment
IEC	60146	Semiconductor converters
IEC	60896	Stationary lead-acid batteries
IEC	61204	Low voltage power supply devices DC output

Chargers and batteries shall be tested together in the factory. Testing of chargers and batteries together at site will also be accepted. All factory tests shall be repeated at site.

Chargers

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Output voltage stability measured for 25% load steps
- Ripple voltage measurement without connected battery
- Ripple measurement (voltage and current) with connected battery (at site will also be accepted.
- Insulation test (to be repeated on site).

Batteries

- Visual inspection (to be repeated on site)
- Insulation test (to be repeated on site)
- Charge test and discharge tests

Fuse Box

- Visual inspection (to be repeated on site)
- Functional tests (on site)
- Insulation test (on site).

Inverters and DC/DC converters

- Visual inspection (to be repeated on site)
- Functional tests (to be repeated on site)
- Heat run (type test)
- Insulation test (to be repeated on site).

Lamps and accessories

IEC	60081	Double-capped fluorescent lamps
IEC	61347	Lamp control gear
IEC	60921	Ballasts for tubular fluorescent lamps
IEC	60155	Glow starters for fluorescent lamps
IEC	60598	Luminaries
IEC	60188	High-pressure mercury vapor lamps
IEC	60400	Lampholders and starter holders for tubular fluorescent lamps
IEC	60901	Single-capped fluorescent lamps
IEC	60662	High pressure sodium vapor lamps
IEC	60192	Low pressure sodium vapor lamps
IEC	60923	Auxiliaries for lamps
IEC	61347	Part 2-13: lamp control gear for LED Modules
IEC	62031	LED modules for general lighting - Safety specifications
IEC	62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specifications

IEC	62612	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Perforce requirements
IEC	62471	Photobiological safety
IEC	62384	DC or AC supplied electronic control gear for LED modules - Perforce requirements
IEC	60838	Part 2-2: miscellaneous lampholders - Connectors for LED-modules
IEC/PAS	62717	LED Modules for general lighting - Performance requirements
IEC/PAS	62722	Luminares Performance

HV-, MV- and LV-cables
All relevant routine and type tests according to:

IEC	60060	High voltage test techniques
IEC	60071	Insulation co-ordination
IEC	60230	Impulse tests on cables and their accessories
IEC	60811	Common test methods for insulating and sheathing materials of electric cables
IEC	60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV up 150 kV
IEC	62067	Power cables with extruded insulation and their accessories for rated voltages above 150 kV up 500 kV
IEC	60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV

a) LV-cables
LV cables shall be workshop tested as per IEC 60502-1 with the following tests as a minimum:

Type tests:
- electrical type tests acc. to: IEC 60502 - 1 Clause 17
- non electrical type tests acc. to: IEC 60502 - 2 Clause 18.

Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 400C water

BHEL INTERNATIONAL OPERATIONS DIVISION New Delhi

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- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm.

Moreover, test certificates shall be provided, proving that each cable type to be used has successfully passed type tests as required by the applicable standards during the last 12 months before award of contract. Otherwise, these tests have to be repeated on sample Sections.

Routine tests: according IEC 60502 – 1, Clause 15
- measurements of electrical resistance of conductors according to Clause 15.2
- voltage tests according to clause 15.3.

Sample tests: according IEC 60502 – 1, Clause 16
- conductor examination according Clause 16.4
- check of dimensions according Clause 16.5 to 16.8
- hot set test for EPR, HEPR and XLPE insulations and elastomeric sheath according Clause 16.9.

b) MV-cables

MV cables shall be workshop tested as per IEC 60502-2 with the following tests as a minimum:

Type tests:
- electrical type tests acc. to: IEC 60502 - 2 Clause 18
- non electrical type tests acc. to: IEC 60502 - 2 Clause 19.

Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
- Test voltage = 3 x Uo
- Test frequency = 500 Hz
- Core environment = 400C water
- Duration of test = 4 month
- Test after 4 months: Dielectric stress withstand >14kV/mm.

Moreover, test certificates shall be provided, proving that each cable type to be used has successfully passed type tests as required by the applicable Standards during the last 12 months before award of contract. Otherwise, these tests have to be repeated on sample Sections.

Routine tests: according IEC 60502 – 2, Clause 16

- measurements of electrical resistance of conductors according to Clause 16.2
- partial discharge test according to Clause 16.3 on cables having cores with conductor screens and insulation screens in accordance with Clause 7.1 and 7.2
- voltage tests according to clause 16.4.

Sample tests: according IEC 60502-2 Clause 17

- conductor examination according Clause 17.4
- check of dimensions according Clause 17.5 to 17.8
- voltage test for cables of rated voltages above 3.6/6 (7.2) kV according to Clause 17.9
- hot set test for EPR, HEPR and XLPE insulations and elatomeric sheath according Clause 17.10.

c) HV-cables

The 230 kV XLPE-Insulated Single-Core Underground Cables and Accessories shall be tested as per latest IEC 62067 including all subsequent amendments and relative standard. The Employer/Engineer shall witness the required Type and Sample tests.

The approval of the Employer/ Engineer or the passing of any such inspection or test will not however, prejudice the right of the Employer/ Engineer to reject the 230 kV XLPE-Insulated Single-Core Cables and accessories if it does not comply with the Specification.

Defects discovered during the type/routine/sample tests shall entitle the Employer/Engineer to reject the cables/accessories fabricated for this Project.

The Tenderer/ Contractor shall fabricate without additional cost the cable lengths and accessories necessary for the tests, over and above those required to complete the Works at Site.

For the definitions of the Type Tests, Sample Tests, Routine Tests and Tests after installation, reference shall generally be made to the relevant IEC Standards.

HV cables and accessories shall be workshop tested as per IEC 62067 with the following tests as a minimum:

Type tests on cable systems: according clause 12:

- Electrical type test according Clause 12.4
  - Check of insulation thickness acc. to Clause 12.4.1
  - Bending test on the cables acc. to Clause 12.4.4 followed by installation of accessories and a partial discharge test acc. to Clause 12.4.5
  - Tan δ measurement acc. to Clause 12.4.6
  - Heating cycle voltage test acc. Clause 12.4.7
  - Partial discharge test acc. to Clause 12.4.5 (at ambient and at high temperature)
  - Switching impulse voltage test acc. to Clause 12.4.8
  - Lightning impulse voltage test followed by a power frequency voltage test acc. to Clause 12.4.9
  - Test of outer protection for joints
  - Examination of cable system with cable and accessories after completion of tests acc. to Clause 12.4.10.
  - Tesitivity of semi-conducting screen acc. to Clause 12.4.11.

- Non electrical type tests according to Clause 12.5
  - Check of dimensions acc. to Clause 12.5.1
  - Tests for determination the mechanical properties of insulation acc. to Clause 12.5.2
  - Tests for determination the mechanical properties of oversheats acc. to Clause 12.5.3
  - Aging tests acc. to Clause 12.5.4
  - Pressure test at high temperature on oversheets acc. to Clause 12.5.6
  - Other test on oversheets according to the type used.
  - Hot set test for XLPE insulation acc. to Clause 12.5.10
  - Measurement of carbon black of black PE oversheats acc. to Clause 12.5.12
  - Water penetration test acc. to Clause 12.5.14.

Also following additional type tests shall be carried by the Contractor at their own cost prior to the first shipment of all offered cable if no type test certificates of identical cables are available:

- Fire Resistant according to IEC 60331, BS 6387
- Flame Retardant according to IEC 60332
- Low Smoke Test according to IEC 61034
- Halogen Content Test according IEC 60754
- Water Tree Test of XLPE Insulation (accelerated)
  - Test voltage = 3 x Uo
  - Test frequency = 500 Hz
  - Core environment = 400C water
  - Duration of test = 4 month
  - Test after 4 months: Dielectric stress withstand >14kV/mm.

Cables and accessories shall have passed type approval tests in accordance with IEC Specifications and details of the cable designs offered shall be given in the appropriate place in the Technical Schedules. Type test reports shall include cable design details and design drawings of each jointing accessory included in the type test.

The Tenderer/Contractor shall submit certified copies of type test certificates covering the proposed Cables.

Routine tests: according Clause 9

- partial discharge test according to Clause 9.2
- voltage tests according to according to Clause 9.3
- electrical test on oversheath according to Clause 9.4

Sample tests: according to Clause 10

- conductor examination according Clause 10.4
- measurement of electrical resistance of conductor according to Clause 10.5
- measurement of thickness of insulation and oversheath according to Clause 10.6
- measurement of thickness of metallic sheath according to Clause 10.7
- measurement of diameters according to Clause 10.8
- hot set test XLPE insulations and elatomeric sheath according Clause 10.9
- measurement of capacitance according to Clause 10.10
- lightning impulse voltage test follows by a power frequency voltage test according to Clause 10.12
- water penetration test according Clause 12.5.14
- Lead alloy composition and behavior (BS 3908, BS EN 12548).

Type tests of accessories

All accessories shall be tested as per IEC 62067 and all subsequent amendments and relative standards considering Test of Outer protection for buried joints (if applicable).

Routine Tests, Insulation Joints

The insulation flange shall be designed to withstand tests voltages as specified in the Technical Data Sheets and shall be tested accordingly.

Routine Tests, Bonding/Earthing Leads

The Bonding/Earthing Leads shall be designed to withstand tests voltages and currents as specified in the Technical Data Sheets and shall be tested accordingly.

Telecommunication installations

IEC 60215 Safety requirements for radio transmitting equipment

Aerials
IEC 60169 Radio-frequency connectors

Power installations up to 1000 V
IEC 60364 Electrical installations of buildings
IEC 61439-4 Particular requirements for assemblies for construction sites (ACS)

Power installation above 1000 V
IEC 60060 High-voltage test techniques
IEC 62271 HV switchgear and control gear
(incl. Appendix AA "Internal Arc Test")

Protection equipment
Equipment for modular static protection systems (e.g. generator, distance, busbar, protection, etc.) pre-assembled in the relevant standardized boards/ cubicles etc. shall be tested in the manufacturers' workshops according to IEC 60255 as far as wiring and proper function is concerned. Simulated inputs (binary signals, current and voltage inputs from test power supplies) shall be used.

Fire alarm system
All relevant routine and type tests according to:
NFPA National Fire Protection Association
DIN VDE 0800 Telecommunications
DIN VDE 0833 Alarm systems for fire, intrusion and hold-up

B0.7.2.5 Control and monitoring equipment

All control and monitoring equipment shall be tested at the manufacturers' works before dispatch to site. Certificates shall be issued for

- synchronizing units
- flow evaluators

On request the correct operation of equipment with specified temperature and humidity limits shall be demonstrated by tests conducted within the limits.

Electrical measuring instruments
All electrical measuring instruments shall be tested in accordance with the following rules and regulations. Alternatively, equivalent standards approved by the Employer's Representative may be used.

IEC 60051 Recommendations for direct-acting indicating electrical measuring instruments and their accessories

IEC 60258	Direct acting recording electrical measuring instruments and their accessories
IEC 61036	Alternating current static watt-hour meters for active energy
IEC 61010	Safety requirements for electrical equipment for measurement, control and laboratory use

Electrical remote indication
Meters for active power, reactive power and similar remote indication equipment:

VDE 0418	Regulations for electric integrating meters
IEC 60338	Telemetering for consumption and demand

Calibration Tests
The Contractor shall conduct calibration tests of the following instruments and equipment:

- all local indicators over the full range of the indicator
- all transmitters over the full range of the transmitter
- all binary transmitters over the full range including initial setting
- all remote indicators over the full range of the indicator
- all recorders over the full range of the recorder
- one of each type of indication loop with circuit resistance of the loop increased to a value which is equal to the highest value expected, and under worst case operating conditions
- all superheated steam thermocouples
- one of each type of thermocouple or resistance element
- all kinds of analogue transmitters over the full measuring range
- all modules and subassemblies for measuring and control e.g. analogue limit monitors, flow evaluators, function generators
- all quantity meters
- all synchronizing units according to IEC standards
- the actual dimensions of all orifices, nozzles, Venturi nozzles have to be checked as per ISO5167.

Closed-loop control systems
All main closed-loop control systems shall be tested for polarity and function in accordance with the applicable standards. Control valves shall be tested in accordance with mechanical functional tests on control valves and shall be performed with the actuator mounted (open to closed position and vice-versa). Actuators shall be subject to mechanical and electrical function tests.

Sequence logic equipment
All sequence logic equipment shall be tested using simulated inputs.

Alarm annunciator and fault printing system

The alarm annunciator and fault printing system shall be tested using simulated inputs.

DCS system

The system shall be thoroughly tested at the manufacturers' workshops before dispatch to site. Test programs shall be devised and these shall subsequently be made available to the Employer's Representative. Tests shall be made to ensure that the system operates correctly within the ambient conditions as specified by the manufacturer and that if these conditions are exceeded, i.e. in the case of failure of the air-conditioning system, that the system will automatically fail safe and that neither hardware nor software will be damaged.

Further I&C equipment

Type test reports shall be provided for the following:

- UPS
- 24 V DC battery chargers
- Batteries
- Control valves
- Instrumentation cables
- Flow nozzle orifice plates
- Measuring instruments
- Local instrument enclosures
- Local instrument racks
- PLCs
- Etc.

Type test reports

The minimum type test reports for each of the major I&C systems shall be as follows:

1. Surge Withstand Capability (SWC) for solid state equipment/ systems
   All solid state systems/ equipment shall be able to withstand the electrical noise and surges as encountered in actual service conditions and inherent in a Power Plant. All the solid state systems/ equipment shall be provided with all required protections that needs the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Hence all front end cards which receive external signals like analogue input & output modules, binary input & output modules, etc. including power supplies, data highway, data links shall be provided with protections that meet the surge withstand capability as defined in ANSI 37.90.1/ IEEE-472. Complete details of the features incorporated in electronic systems to meet this requirement, the relevant tests carried out, the certificates etc. shall be submitted with the proposal. As an alternative to above, suitable class of EN61000-4-12 which is equivalent to ANSI 37.90.1/ IEEE-472 may also be adopted for SWC test.
2. Dry heat test as per IEC 60068-2-2 or equivalent
3. Damp heat test as per IEC 60068-2-3 or equivalent

4. Vibration test as per IEC 60068-2-6 or equivalent
5. Electrostatic discharge tests as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic field immunity as per EN 61000-4-3 or equivalent

Tests as listed under items number 5 to 7 as applicable for electronic cards only as defined under item 1 above.

B0.7.3 Testing at site

B0.7.3.1 Civil works testing

The Contractor shall carry out all required civil construction tests. Thereby part of the test like concrete and earthwork tests have to be carried out at site, other tests have to be performed in the manufacturer workshops.

The Contractor shall submit all test certificates of materials subject to approval and shall arrange for tests of all materials to be carried out in laboratories on site or elsewhere. The cost of all test equipment, samples, tests and transport to the laboratory shall be borne by the Contractor.

The testing operations shall be performed in accordance with the relevant codes and standards and under the supervision of the Employer.

Where in the specifications materials are specified to be approved samples shall be submitted for approval at the earliest possible date and strictly before any purchasing or delivery to the site is made. The individual tests and inspection for the materials, supply and execution shall be carried out in compliance with the requirements of the individual technical specifications. In the case of rejection, further samples of the rejected materials shall be submitted to SC until they are approved or the material is replaced. The Employer may reject any material which in his opinion is not in accordance with the approved standard. All samples shall be submitted free of charge to the Employer.

The characteristics as determined in the samples which are approved shall indicate the standard to be maintained in the materials used in the execution of the works.

The test samples of materials subject to approval by the Employer shall be kept in a safe place and protected against damage or deterioration until completion of the works.

For materials (e.g. steelwork, pipes, ducts, etc.) to be manufactured in workshops respective manufacturer test certificates including test results shall be submitted to the Employer subject to approval.

After final completion of certain civil structures/ parts to be ready for erection of further equipment individual "Civil Completion Certificates" shall be issued by the Contractor under the following conditions:

- Except for minor items of work that would not affect the safety, all civil works for applicable parts, structures or buildings have been carried out and tested
- All such civil works are in a manner that does not void any subcontractor or vendor warranties or violate any applicable law or applicable permit
- Punch List has been agreed upon by the Employer and the Contractor
- Contractor warrants that all necessary works have been undertaken and all applicable parts, structures or buildings are ready for erection.

If the Employer is satisfied that the pre-conditions for the issuance of the Civil Completion Certificate for the respective civil structures/ parts have been met the Civil Construction Completion Certificate shall be signed off by the Employer.

Further testing requirements for civil works are specified in **Section B9**.

An indicative field quality plan for civil works to be followed by the Contractor at site is required to be submitted with the Tender.

B0.7.3.2 Erection tests

General
During erection all required erection tests as well as final erection checks of the mechanical completion of the systems and part thereof have to be performed.

The Employer shall have the right to witness on request all tests on site and shall be informed of site test 24 hours in advance.

After successful mechanical completion of each system, Individual Erection Completion Certificates will be issued.

The activities necessary for mechanical completion shall include but not be limited to following testing:

- visual inspection after unloading at site
- checking of completion of relevant systems
- completion of buildings and civil works
- test of ventilating and air-conditioning units
- alignment of rotating equipment coupled on site
- safety audit
- testing of site welds (non-destructive examinations)
- pressure testing, leak tests, tightness tests

- checking of pipe hangers, supports, guides, etc.
- pipe line and equipment flushing and cleaning
- chemical protection of piping systems
- checking of coating
- testing of cranes and hoists.

Electrical equipment tests

The following tests or measurements must be made during and after erection but before any item of equipment is put on trial operation:

- design and visual checks
- screwed connections for correct assembly
- terminals and terminal connections for correct assembly
- checking of earthing connections and testing of earthing resistances
- measurement of insulation values (didactic tests)
- verification of earthing conditions
- fire-proof partitioning
- marking, inscription, provision of designation plates
- rotating-field measurement
- phase coincidence with 2 half-busbars
- voltage checks
- polarity checks in the case of DC voltages
- fuses, overcurrent trips, short circuit trips, time settings, relay settings
- oil levels
- status indication, alarm and trip signals
- checks on wiring and cabling for conformity with the constructional circuit drawings and plans
- high voltage tests
- current and voltage transformer circuits
- functional test of all protection relays including winding and oil temperature monitoring as well as Buchholz protection etc.
- interface with the DCS and SCADA.

The tests shall be carried out according to relevant standards.

The Contractor shall submit for each test of all equipment a method statement, with relevant diagrams explaining the procedure of the tests and test criteria supported by relevant standards and test methods.

All major equipment shall have a separate test package.

All high voltage tests shall be carried out at 50 Hz. Equipment for which DC tests is proposed shall be justified and approved by Employer/Engineer. HV tests of switchgears shall be carried out with the relevant circuit breakers in open and closed positions.

Unless otherwise agreed, all erection and civil works related to the equipment shall be completed before starting any site tests.
All switchgears shall be verified by primary injection in addition to secondary injection.

Generators
This Section covers the specific requirements for the site tests and performance tests requirements in the turbine plant.

These tests shall include:

- Routine tests as per IEC 60034 - as far as practicable under site condition comprising of:
  - testing of running behaviour (overspeed)
  - determination of temp. rises of coolants and lubricants for bearing and shaft seals
  - determination of friction losses
  - recording of no-load saturation characteristics and determination of core losses
  - measurement of shaft voltage
  - verification of phase sequence and appropriate terminal marking
  - measurement of excitation current and determination of losses at rated current on short circuit
  - calculation of efficiency from sum of individual losses
  - winding insulation measurement
  - HV test on windings
  - functional test of accessories and attachments
  - measurement of excitation response time – GTG: measuring will be carried out at site during commissioning
  - overall characteristics coupled with generator and AVR cubicle at no load (applicable for the assembled unit consisting of generator, exciter and voltage regulator) – GTG: measuring will be carried out at site during commissioning.

The Contractor has to provide a detailed test procedure subject to approval by the Employer/Engineer.

Motors
Tests at Site (with motor coupled):

- measurement of insulation resistance
- measurement of shaft current
- measurement of motor vibrations
- at motors rated 47 kW or higher, in addition:
  - oscillographic measurement of starting current (if not performed during workshop testing)
  - measurement of starting period.

Switchgear for Voltages above 1 kV
The complete installation shall be tested at site as follows:

- dielectric test
- visual inspection
- contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- HV test
- mechanical functioning test
- test of the functional sequence
- testing of all interlocks
- testing of all protection relays and circuits by primary/secondary injection and functional tests of the arc protection
- testing of high speed transfer systems
- testing of all alarms (local and remote).

LV switchgear (AC and DC)
The complete switchgear and the individual apparatus shall be tested on site as follows:

- visual inspection
- dielectric test
- contact resistance/torque test of bus bar joints
- CT's, VT's ratio, magnetisation characteristic and burden measurement
- testing of all interlocks
- setting and testing of all protection relays and circuits by primary/ secondary injection. Test kit of adequate rating to be provided
- testing of automatic change over devices
- testing of all alarms (local and remote)
- functional test
- test of the functional sequence.

Setting and functional test of protection devices (primary injection method). However, test plugs and socket facilities for secondary injection tests shall also be made available. Tests kits of adequate ratings shall be made available for the tests.

Batteries and chargers
Chargers and batteries shall be tested together in the factory. All factory tests are to be repeated at site.

Chargers
- visual inspection (to be repeated on site)
- functional tests (to be repeated on site)
- heat run (type test)
- output voltage stability measured for 25% load steps
- ripple voltage measurement without connected battery

- ripple measurement (voltage and current) with connected battery
- insulation test (to be repeated on site).

Batteries
- visual inspection (to be repeated on site)
- insulation test (to be repeated on site)
- charge test and discharge tests (100%).

Fuse Box
- Visual inspection (to be repeated on site)
- Functional tests (on site)
- Insulation test (on site).

Inverters & DC/DC Converters
Following test shall be carried out:

- visual inspection (to be repeated on site)
- functional tests (to be repeated on site)
- insulation test (to be repeated on site).

Earthing and lightning protection
The complete earthing and lightning protection systems shall be tested as follows:

- The earthing system as a whole shall be tested and verified before putting any major equipment into operation.
- visual inspection of exposed elements
- Measurement of the earth electrode potential UE by the voltmeter/ ammeter method, test current 100 300 A or an equivalent, approved method if above will be proved to be not feasible,
- measurement of the touch potential UB,
- measurement of step potential.

Diesel generator units
The diesel generator units (DGU) shall be thoroughly tested at site. The acceptance tests shall be performed according to the Technical Specifications and acc. to ISO 8528 6:1993 (E) and ISO 3046-1:1995 (E) and -3:1989 (E) for the diesel engine. At site the diesel engine shall be measured and documented according to the stipulations made in Clause 7.6.20. The exhaust gas shall be invisible when the Unit is operating at loads between 50 and 110%. The diesel engine's filter smoke number shall be measured according to BOSCH Index No. 3 or better within a load range from 60 to 100%. A test report in English language shall be issued according to ISO 8528:1993 (E). Upon full satisfaction of the Employer/Engineer after the successful operation tests, in every respect, and that all components are working properly, the DGU with all ancillaries shall

be operated at 100% output for 48 hrs without failure or interruption whatsoever. The performance test measurements of the DGU shall be performed according to ISO 8528 6:1993 (E) for the diesel generator unit, ISO 3046-1:1995 (E) and -3:1989 (E) for the diesel engine and latest issue of IEC 60034-2 for the Generator. All guaranteed values shall be assumed to include all necessary tolerances for accuracy of testing, sampling, instrumentation, notwithstanding the performance test code standard. No further tolerances of any kind shall be permitted.

230 kV XLPE Cables

Test after laying is to be recommended by the manufacturer considering the following minimum requirements and recommendations from CIGRE WG.21.9 (Electra No.173 August '97), IEC 62067 and other applicable standards to Employer/ Engineers approval.

- visual and function test of bonding/earthing system
- phase Identification Test
- conductor and screen/sheath Continuity Test
- primary connection check
- cable connection bolt tightness check
- cable supporting check
- cable fixing check
- insulation resistance test before and after installation
- DC conductor resistance test (IEC 60228)
- contact resistance test of connecting bars in link boxes
- capacitance test
- earthing measurements
- positive/negative and zero sequence impedance measurements
- testing of SVL
- cross bonding check, primary injection Subsequent repeat tests (after guarantee period)
- DC sheath test according Clause 5 of IEC 60229 between metallic sheath/screen/armouring including cross bonding system, etc. and ground.
- AC voltage test according IEC 62067 **Section 14.2**.
- measurements of induced voltages on pilot/telephone cables installed in parallel with the power cables.

Tests accord the Electricity Transmission Code of Bangladesh and Great Britain

Any other tests required to demonstrate compliance with the above indicated Grid Codes.

B0.7.3.3 Pre-commissioning tests

Preconditions for the pre-commissioning are:

- the issue of the individual Erection Completion Certificates;

- the rectification of all relevant erection punch points; and
- the availability of the accepted commissioning test program and commissioning procedures.

The pre-commissioning tests shall cover mainly the functional tests of the individual items of all mechanical, electrical and I&C systems including their alarm and tripping systems. Following tests shall be included, but not limited to:

Mechanical equipment

- Individual pre-commissioning runs of all rotating equipment such as pumps, compressors, dosing equipment etc.
- Functional tests of the mechanical equipment
- Testing and adjustment of safety devices

Electrical equipment

As far as not already covered by the erection tests the pre-commissioning tests shall cover:

- Voltage tests
- Generator and transformer protection system checks
- Automatic voltage and reactive power control (AVQC), governor setting and adjustment and response to grid system signals
- Trip tests
- Functional tests of the equipment e.g.:
  - Motor checks
  - Circuit breakers, LV, MV, HV cabling and switchgears checks for operability
  - Batteries, chargers and UPS checks for operability
- Remaining tests on turbine generator: In addition, a repetition of winding resistance and insulation resistance measurement, as well as dielectric tests shall be carried out in any case on each turbine generator.

Control equipment

- Comprehensive loop tests shall be performed for all measuring loops at least for 0, 50% and 100% value.
- Closed loop control checks up to DCS (for all functions like indication, control, alarms, etc.):
  - Polarity and function test in accordance with the applicable standards.
  - Control valves shall be tested in accordance with mechanical functional tests on control valves and shall be performed with the actuator mounted (open to closed position and vice-versa)
  - Actuators shall be subject to mechanical and electrical function tests.
- All sequence logic equipment shall be tested using simulated inputs.
- The alarm annunciation and sequence of event recording system shall be tested using simulated inputs.
- Binary field contact circuit fault detection.

- Functional tests of control equipment, interlocks, inter-tripping, protection inputs, etc.
- Test of signal exchange with other systems (also with third parties – like LDC, etc.)
- Archiving system (capacity, consistency, redundancy, access times).
- Reports generation
- Emission analyser calibration and emission evaluation tests
- Calibration of metering system (accuracy shall be proven by certificates)

B0.7.3.4 Tests on Completion (Commissioning tests)

Preconditions of the Tests on Completion are:

- the successful completion of the individual erection checks of all items of the whole system;
- the issuing of the Final Erection Completion Certificate; and
- the successful completion of all pre-commissioning test.

Should the Employer decide that the preconditions for the Tests on Completion have not been adequately met, the Employer will advise the Contractor accordingly and withhold the commencement of the the Tests on Completion until the outstanding work is completed.

The Tests on Completion shall prove that the Plant is prepared and adjusted to ensure the correct functioning of the individual components and of the complete Plant.

The Tests on Completion shall cover at least following tests:

- Protection tests
  - Operation of selected turbine train protection devices including the following as a minimum:
    - fire protection
    - boiler protection
    - steam turbine protection
    - generator protection
    - transformer protection.

Method of alarm/ trip condition reset for subsequent starting.

- Operation of auxiliary systems:

Method of changeover of main equipment to stand-by equipment prior to Plant starting (see start-up tests) and during normal operation for fuel oil, coal handling, ash handling, oil lube and cooling systems

- Operation of fire protection systems.

- Isolation procedures
  - Method of isolation of plant equipment for safe shut-down and maintenance procedures including as a minimum:
    - HV station and unit supplies
    - LV supplies
    - fuel oil systems
    - coal handling systems
    - ash handling systems
    - fire protection systems.
- Protection systems/ settings, in accordance with agreed design and the requirements of the transmission system.
- Start-up tests
  - normal semi-automatic start to preset load
  - staged semi-automatic including start to synchronous speed, manual synchronizing (including synchro-check), automatic synchronizing, manual and automatic loading
  - starting with stand-by auxiliaries
  - operation of all auxiliaries.
- Verification of start-up times and loading rates of power unit and steam generator at various downtime conditions.
- Power unit(s)/Plant, to test partial and full load rejection to demonstrate
  - full load rejection tests to measure transient maximum speed and steady state speed at normal governor droop setting
  - method of resynchronism to be demonstrated steam turbine bypass operation capability.
- Power unit(s)/Plant, to verify and check
  - operating stability when operated between 30% and 100% nominal load conditions with load variations by increasing or decreasing the electric load
  - start-up/main fuel change-over:
    - semi-automatic change-over from fuel oil operation to coal operation
    - semi-automatic change-over from coal operation to fuel oil operation.
- Demonstration of the capabilities of the power unit to operate at rated voltage and frequency, at power factors and reactive conditions between 0.85 (lag) and 0.95 (lead).
- Start-up tests of the Plant equipment, facilities and systems including checking of automatic change-over of standby facilities as well as fuel.
- Verification of vibration guarantees.
- Environmental monitoring equipment, water quality monitoring equipment, functioning tests and verification of guarantees.
- Demonstration of the teledispatching and telemetering systems.
- Verification of Active Power Response and Voltage Control Response according to the requirements specified in the Network Connection Conditions.

- Demonstration of proper controlling, monitoring and recording according to the requirements of the Grid Code, including but not limited to the following tests:
  - Reactive Power
  - Fault Detection and Clearing Limits
  - Load Following Capability
  - Black Start (if applicable)
  - Voltage Following Capability (AVQC)
  - Excitation System and Power System Stabiliser
  - Primary, Secondary and High Frequency MW Response
  - Unit Start
  - Despatch Ramp Rate
  - Protection System
  - House Load Operation
  - Underfrequency Relay
  - Loss of AC Power Supply
  - Minimum Load
  - Site Test for Validation
  - Verification of completeness of scope of supply.

B0.7.3.4.1 Additional test in accordance with the PPA

Tests prior to synchronisation of each generating unit of the Plant
According to the requirements of the BPDB which are part of the PPA, the Contractor shall carry out the following additional tests prior to synchronisation of each generating unit of the Plant:

- automatic voltage regulator setting and adjusting in stand-still condition and with the generator running at no load
- turbine governor control checks, including a steam governor overspeed test (This test may be performed after a specified period of running of the Unit on load as per the manufacturer`s recommendation)
- open circuit and short circuit tests on the generator
- functional testing and timing of high voltage switchgear in the substation of the Facility
- The Company and BPDB shall verify that the protection level settings for switchyard protection equipment are as agreed by the Joint Coordinating Committee
- Voltage phasing checks will be carried out between the Grid System and the Facility; and

All inter-tripping circuits between the Plant and BPDB equipment shall be proved.

Tests for commissioning of each generating unit of the Plant
In addition to the above specified tests and according to the requirements of the BPDB which are part of the PPA, the following tests shall be carried out

by the Contractor for commissioning of each generating unit of the Plant after completing the tests set out before:

a. **Dependable Capacity Test**
Refer to Section **0.7.4.**

b. **Reliability Run**
Refer to Section **B.0.7.5**

c. **Automatic Voltage Regulator ("AVR") Droop Test**
The AVR will be demonstrated to control the steam turbine generator voltage over its entire set range.

d. **Steam Turbine Governor Operation Test**
The operation of the steam turbine speed governor will be demonstrated.

e. **Reactive Capacity Test**
This test will demonstrate the capability of the Plant to operate at rated voltage and frequency at power factors and under reactive conditions in accordance with the manufacturer's generator rating curves to be provided by the Contractor, insofar as these tests can be accommodated within the grid system.

f. **Minimum Load Capability Test**
This test will demonstrate the capability of each Unit to be operated at minimum stable load while the steam turbines, and auxiliaries remain in a stable and controlled condition, see also

B0.7.3.4.2 72h Full Load Continuous Test Run

After successful completion of the Tests on Completion and availability of the Commissioning Completion Certificate (CCC), signed by the Employer and the Contractor, the "Authorization to Start the 72 h Full Load Continuous Test" shall be signed.

No trip is admitted during these 72 h. Should the Plant or a Unit, as the case may be, not follow the requested load during the 72 h test, the test shall be restarted.

B0.7.4 Performance Tests

Performance Tests of the Unit(s)
After successful completion of the 72h Full Load Continuous Test Run and after relevant test protocols have been accepted by the Employer for the Unit(s) and Common Facilities, the Contractor shall be allowed to prepare the Unit(s) for the Performance Tests.

For the Unit(s) following guarantees given in the **Technical Schedule B0** shall be tested during the related Performance Test; this includes:

- Performance guarantees of the Unit(s)
- Operating guarantees
- Emission guarantees
- Guarantees of steam generator(s), steam turbine generator(s), flue gas treatment systems etc.

Performance Test of the Plant
After completion of the Performance Tests of the Unit(s), the guarantees of the Plant and the common facilities shall be tested in a separate Performance Test; this includes:

- Performance guarantees of the Plant
- Emission guarantees of the Plant
- Emission guarantees of the auxiliary boiler
- Noise guarantees
- Guarantees of the water and waste water treatment systems
- Effluent and water outfall guarantees.

Dependable Capacity Test according to the PPA
Dependable Capacity means- means at any given time the net amount of capacity at the tariff metering; either for the first generating unit or for the Plant, as the case may be, as determined by the most recent dependable capacity test which shall be comply with ASME standards and shall be carried out as part of the Reliability Run. The Dependable Capacity of the Plant is measured at the Delivery Point. It equals the average Export Power Output, corrected to Reference Site Conditions using correction factors, delivered during twelve continuous thirty (30) minute periods divided by six (6) hours.

Performance Tests shall be conducted in accordance with following standards:

- the Plant — ASME PTC 46
- steam generator — ASME PTC 4 (or equivalent ISO)
- steam turbine — ASME PTC 6 (or DIN 1943 or equivalent ISO)

- cooling tower ASME PTC 23
- FGD plant ASME PTC 40.

The curves required for the correction of the power output and specific heat rate to the site specified ambient conditions shall be listed in the technical schedules of the Plant performance and steam generator and steam turbine performance, and shall be submitted with the Tender. These curves shall be conclusive and no extra correction shall be given.

The margins required for instrument inaccuracies and for all other reasons shall be deemed to be included in the guarantee figures. The actual figures determined during performance tests shall hence be not corrected with any margins due to instrument inaccuracies prior to comparison with the guarantee figures.

Degradation and fouling during commissioning and other operation prior to Provisional Acceptance shall be deemed to be included in the guarantee figures. The actual figures determined during performance tests shall hence be not corrected for any degradation or fouling effect prior to comparison with the guarantee figures.

Degradation curves for the Plant and Unit(s) performance shall be submitted by the Contractor with bid. The curves shall show the equipment's degradation in power output and heat rate versus equivalent operating hours. The curves shall be applicable up to and including final major overhaul.

Test program

In due time prior to the tests a detailed procedure covering the testing to be undertaken and the methods to be employed shall be provided by the Contactor. The test procedure shall also detail areas of responsibility and the items that specifically require preparation and agreement before the tests can be carried out.

The test program shall cover the following documents but not be limited to:

- test procedure and standards (including proposed formulae / curves and standards)
- test schedule
- type of test
- manpower and deployment schedule of the Contractor for performing the tests forms of test records and report
- description of instrumentation to be used, including accuracy, and calibration test results
- method of data recording
- list of all auxiliary loads that will be operating during the tests. The list of auxiliary loads shall be provided with the test program and agreed in the Test Procedure.
- method and equations/correction curves used for adjustment of recorded data to the design conditions.

Test responsibility
All tests shall be prepared and conducted by the Contractor. The Plant shall be operated by Contractor's operation personnel.

The Employer and/or an independent third party, awarded by the Employer.shall have the right to witness the tests.

Contractor's personnel appointed to carry out the tests shall be adequately skilled and experienced. Information on these personnel shall be provided to the Employer as part of the test program for review.

Test instrumentation
The Contractor shall supply and install all test instrumentation needed to conduct the tests. Temporary instrumentation installed for test purposes only and shall be retained at Site upon the satisfactory conclusion of all tests and shall be then removed.

All instruments to be used for the test shall be strictly dedicated calibrated measurement equipment. Each measuring instrument used shall be according to controlled and provided with a valid calibration certificate.

The calibration shall be carried out by an independent third party, which shall have appropriated quality standards and which shall be to be approved by the Employer, except for instruments which are calibrated and certified at a certified laboratory and holding the authorized traceability certificate.

Test Duration
The test shall begin after the Plant or a Unit including common facilities, as the case may be, has established stable operation, as judged by the Employer and/or an independent third party, awarded by the Employer.

The test duration shall be in accordance with the standards and codes.

One 60-minute test run shall be conducted for each guaranteed load point, during which the operating conditions shall remain within the defined plant stability criteria.

Test conditions
Performance tests shall be conducted at conditions close to the conditions of the Guarantees. Thereby the boiler and steam turbine cycle shall be adjusted to the conditions of the corresponding heat balance diagram.

Since the accuracy of the test results highly depend on the exact water-steam cycle arrangement respective cycle isolation is required to avoid any unknown cycle leakages. The valve position list has to be provided by the Contractor prior to the performance test. This cycle arrangement shall fully

remain during the whole testing period. Any changes of the performance conditions during the tests are not allowed.

Test evaluation
The Contractor shall submit for the acceptance of the Performance Test all detailed measurements, calculations and individual test results (such as, but not limited to turbine efficiency calculations, generator and transformer details, condenser performance, feedwater heaters and deaerator details, boiler efficiency calculations, pulverizing fineness and other results, air heater temperature traverses and leakage results, coal handling system performance, ash characteristics and ash handling systems performance, ESP and FGD performance and emissions, individual auxiliary power consumption figures, major consumers performance, noise and effluents etc.) and the corrections made based on the correction curves.

The Performance Test report shall be submitted by the Contractor. This report shall include, as a minimum, the following:

- description of the test procedures
- instrumentation details and calibrations (not older than six months)
- full process flow diagrams for fuel, air and flue gas and water and steam with indication of instrument position
- standards that were used
- test logs and summary (arithmetic average) of test readings used for performance calculations
- full set of correction curves
- calculations
- instrument calibration certificates
- list of all auxiliary loads that were operated during the tests
- performance tests results for the "As-run" condition and for the "Corrected as-run conditions"
- conclusions of performance tests: test passed or not.

B0.7.5 Reliability test run

After successful completion of all Performance Tests the Plant or a Unit including common facilities, as the case may be, shall start the 30 (thirty) days Reliability Test Run.

During the Reliability Test Run the Contractor shall demonstrate that the Plant or a Unit including common facilities, as the case may be, is fit for commercial operation.

During the specified periods, the Plant shall be operated continuously and in accordance with the prevailing power requirements of the Transmission System/BPDB or as required by the Employer.

During the Reliability Test Run the Employer's operation personnel shall operate the Plant under the full supervision and the responsibility of the Contractor's Personnel and according to the O&M manual as supplied by the Contractor.

For the successful completion of the Reliability Test Run, a maximum of 4 trippings of not more than combined outage of 24 hours are allowed, otherwise the Reliability Test Run will be considered as failed and a new Reliability Test Run will have to be executed until the test has been completed.

At the conclusion of the Reliability Test Run the Contractor shall request from the Employer the issuing of the Provisional Acceptance Certificate (PAC).

A list of minor pending items, which are at the judgment of the Employer do not jeopardize the trouble-free operation of the Plant or a Unit including common facilities, as the case may be, could be attached to that certificate. The envisaged completion date for each item shall be stated in it.

With the issuing of the PAC the Employer takes legal possession of the Plant or a Unit including common facilities, as the case may be, and the Warranty Period will begin.

During the Warranty Period the Contractor has to keep at site at least three Warranty Engineers at Site. Part of their duty shall be inter alia to complete in time the works for the minor punch items mentioned in the PAC. They shall issue, together with the Employer, special reports, should any damages occur to any equipment. Moreover they shall assist the Employer during the daily plant operation and issue additional operational instructions, if requested. They shall assist the Maintenance Superintendent in his work organization and spare part handling procedure.

At the successful conclusion of the Warranty Period, the Contractor shall request the Employer to issue the Final Acceptance Certificate (FAC).

Additional requirements as per the PPA The Facility shall operate continuously (without interruption) for

Seventy two (72) continuous hours at then demonstrated Dependable Capacity. For ninety six (96) hours the output shall be as requested by BPDB in accordance with the Dispatch provisions as outlined in the PPA.

B0.8 Abbreviations

(Please refer also to relevant Sections "**Standards and Codes**" **and "Units of measurement**")

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AGC	Automatic Grid Control
ASC	Average Site Conditions
ATRS	Automatic Turbine Run-up System
ATT	Automatic Turbine Testing System
AVQR	Automatic Voltage and Reactive Power Control
AVT	All Volatile Treatment
BFP	Boiler Feedwater Pump
BMCR	Boiler Maximum Continuous Rating
BMS	Burner Management System
BOD	Biological Oxygen Demand
BOP	Balance of Plant
BOQ	Balance of Quantities
BPDB	Bangladesh Power Development Board
BPS	Boiler Protection System
CCR	Central Control Room
CCTV	Closed Circuit Television
CD	Chart Datum
CEMS	Continuous Emission Monitoring System
CHP	Coal Handling Plant
CO	Carbon Monoxide
COD	Commercial Operation Date
COD	Chemical Oxygen Demand
CT	Current Transformer
CW	Cooling Water
DAF	Dry Ash Free
DC	Direct Current
DCDB	DC Distribution Board
DCS	Distributed Control System
DDCMIS	Distributed Digital Control Monitoring & Information System
DCS	Distributed Control System
DOE	Department of the Environment, Bangladesh
DOSH	Department of Safety and Health, Bangladesh
DPC	Damp Proof Course
DWT	Dead Weight Tons
ECP	Electrochlorination Plant
EHG	Turbine Electro Hydraulic Governor Control System
EHSG - TTP	IFC Environmental Health and Safety Guidelines Thermal Power Plants

EHV	Extra High Voltage (500 kV)
EIA	Environmental Impact Assessment
EMC	Electro-Magnetic Compatibility
EPC	Engineering, Procurement, Construction
ESP	Electrostatic Precipitator
ETP	Effluent Treatment Plant
FDF	Forced Draught Fan
FEGT	Furnace Exit Gas Temperature
FGD	Flue Gas Desulphurization Plant
FTU	Field Mounted Termination Unit
GCV	Gross Calorific Value
G-EHSG	IFC General Environmental Health and Safety Guideline
GJ	Gigajoule
GPS	Global Positioning System
GRP	Glass Fiber Reinforced Piping
GWh	Gigawatt hour
GSO	Grid System Operator
HART	Highway Addressable Remote Transducer
HAZOP	Hazard and Operability Study
HCSD	High Concentration Slurry / Solids Disposal
HDPE	High Density Polyurethane
HHV	Higher Heating Value
HMI	Human Machine Interface
HRC	High Ruption Capacity Fuse
HV	High Voltage
HVAC	Heating, Ventilation, Air Conditioning
Hz	Hertz
I&C	Instrumentation and Control
IDF	Induced Draught Fan
IOD	Initial Operation Date
IP	Intermediate Pressure
IPL	Independent Protection Layer
IPP	Independent Power Producer
IR	Infrared
kV	Kilovolt
kW	Kilowatt
LAN	Local Area Network
LCC	Local Control Center
LCV	Lower Calorific Value
HSD	High Speed Diesel
LHV	Lower Heating Value
LIE	Local Instrument Enclosure
LIR	Local Instrument Rack
LP	Low Pressure
LV	Low Voltage
LVS	Large Video Screen
MCC	Motor Control Center
MCL	Maximum Continuous Load

MCR	Maximum Continuous Rating
MCWP	Main Cooling Water Pump
MDBFP	Motor Driven Boiler Feed Pump
MLSD	Land Survey Datum
MNCL	Minimum Continuous Load
MNCR	Minimum Continuous Rating
MOV	Motor Operated Valve
MV	Medium Voltage
MVA	Megavolt Ampere
MVAR	Megavolt Ampere Reactive
MWh	Megawatt hour
MWQCS	Marine Water Quality Criteria and Standards
NCC	Network Control Center
NDE	Non Destructive Examination
NFPA	National Fire Protection Association
NLDC	National Load Dispatch Centre
NO_x	Nitrogen Oxides
NOR	Notice of Readiness
NPSH	Net Positive Suction Head
NRV	Non Return Valve
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OHL	Over head line
P&I	Piping and Instrumentation
P&ID	Piping and Instrumentation Diagram
PA	Public Address
PABX	Private Automatic Branch Telephone Exchange
PA	Primary Air
PADO	Plant Performance Analysis, Diagnosis and Optimization System
PAF	Primary Air Fan
PC	Pulverized Coal
PCDD	Polychlorinated Dibenzodioxins
PCDF	Polychlorinated Dibenzofurans
PF	Performance Fuel
PLC	Programmable Logic Controller
PPA	Power Purchase Agreement
PQR	Procedure Qualification Record
PSS	Power System Stabiliser
PVC	Polyvinyl Chloride
PWD	Public Works Department
PWHT	Post welding heat treatment
QA	Quality Assurance
RAPH	Regenerative Air Preheater
RC	Reinforced Concrete
RSC	Reference Site Conditions
SA	Secondary Air
SAH	Steam Air Heater

BIFPCL

INTERNATIONAL OPERATIONS DIVISION New Delhi-3

SCADA	Supervisory Control and Data Acquisition
SCAPH	Steam Coil Air Heater
SCS	Substation Control System
SER	Sequence of Events Recording
SG	Steam Generator
SI	Soil Investigation
SIL	Safety Integrity Level
SO_2	Sulphur Dioxide
SOE	Sequence of Events
SSC	Summer Site Conditions
ST	Steam Turbine
STG	Steam Turbine Generator
SWAS	Steam and water analyses system
TCS	Technical Comment Sheet
TDS	Total dissolved solids
TEFC	Totally enclosed Fan cooled
TG	Turbine Generator
TIG	Tungsten Inert Gas
TLA	Three-Letter Abbreviation
TMC	Turbine Maximum Capacity
TMCR	Turbine Maximum Continuous Rating
TSCS	Turbine Stress Control System
TSI	Turbine Supervisory Instruments
UHF	Ultra High Frequency
UV	Ultraviolet
VDU	Video Display Unit
VT	Voltage Transformer
VMS	Vibration monitoring system
VWO	Valves Wide Open
WSC	Winter Site Conditions
WPS	Welding procedure specification
WTP	Water Treatment Plant
WWD	Weather Working Days
WWTP	Waste Water Treatment Plant

B0.9 Technical Schedules

The following technical schedules comprise part of this specification. The data and requirements specified in the respective forms are to be adhered to and the missing data of forms are to be completely filled in. The completed technical schedules are to be submitted with the Bid.

B0 Technical Schedule General
B0 Sub-supplier List

	TECHNICAL SPECIFICATION FOR			**Technical**	**PE-TS-421-179-N001 (Rev 0)**
	PLATE HEAT EXCHANGER			**Section**	**IB**
	DATASHEET - A			**Rev**	**0**
				Date	**06/01/2018**

	PROJECT			**2 x 660 MW MAITREE BANGLADESH STPP**	
1.0	**General**			**PHE for TG & Station Aux.**	**PHE for SG Aux.**
1.1	**Number of Plate Heat Exchanger**		Nos	Total Four (4) nos i.e. [1W+1S] for each unit	Total Four (4) nos i.e. [1W+1S] for each unit
1.2	**Arrangement**			2 x 100% per unit	2 x 100% per unit
1.3	**Location**			Indoor	
1.4	**Primary side (Hot) Fluid**			Passivated DM water (Refer enclosed water analysis)	
1.5	**Secondary side (Cold) fluid**			Sea Water (Refer enclosed water analysis)	
1.6	**Connecting Pipe size**	(Primary Side)	NB	600	300
		(Secondary Side)	NB	500	300
1.7	**Maximum permitted Length of the PHE**		mm	Length 5000 mm (excluding reducer)	
2.0	**Design**				
2.1	**Design Code**			Latest BS/DIN/ASTM/ASME Standards	
2.2	**Design Pressure**		Kg/cm^2 (g)	10	12
2.3	**Operating Pressure**	(Primary Side)	Kg/cm^2 (g)	About 5.8-6.8 Kg/sq. cm(g)	About 8.7-9.7 Kg/sq. cm(g)
		(Secondary Side)	Kg/cm^2 (g)	About 4.0-5.0 Kg/sq. cm(g)	About 4.0-5.0 Kg/sq. cm(g)
2.4	**Mechanical Design Temp.**		°C	70	
2.5	**Minimum Heat Transfer Area**		Sq. M.	-	
2.6	**Specific Heat of Fluid**	**(Primary Side)**	Cal/gmDeg. C	1.00	
		(Secondary Side)	Cal/gmDeg. C	0.94	
2.7	**Density of Fluid**	**(Primary Side)**	gm/cc	1.00	
		(Secondary Side)	gm/cc	1.03	
3.0	**Guaranteed Performance Requirements for each Heat Exchangers in fouled condition:**				
3.1	**Flow rate**	(DMCW Side)	M^3/hr	1920	600
		(ACW Side)	M^3/hr	1920	600
3.2	**Inlet temperature**	(DMCW Side)	°C	46.2	45.1
		(ACW Side)	°C	36	36
3.3	**Outlet temp**	(DMCW Side)	°C	38	38
		(ACW Side)	°C	44.5	43.4
3.4	*** Allowable pressure drop across heat exchanger from inlet to outlet in fouled conditions at design flow**	(DMCW Side)	MWC	7	
		(ACW Side)	MWC	7	
3.5	**Design Heat Load per PHE**	(DMCW Side)	Kcal/Hr	15666000	4214400
		(ACW Side)	Kcal/Hr	15666000	4214400
	*** High pressure drop than the specified figure will not be accepted, no credit shall however be given for lower pressure drop in bid evaluation. Pressure drop mentioned shall be calculated against flow mentioned at S. No 3.1. of this datasheet. Each heat exchanger shall be capable of passing a flow of at least 1.1 times the design flow rate on both primary and secondary water sides. Bidder shall indicate maximum pressure drop through the heat exchanger under this condition.**				
4.0	**Additional HT plates on Design Plates**		%	NIL	NIL
5.0	**Heat Transfer Coefficient/Margin**				
5.1	**Overall fouling resistance (minimun)**		Hr m2deg C/Kcal	0.00008	
5.2	**Minimum corrosion allowance on pressure parts,nozzles,sliding channel and frame (refer note 1)**		mm	1.6	
6.0	**Material of Construction :**				
6.1	**Heat Transfer Plates (Minimum acceptable plate thickness 0.5 mm). Refer Sl. no. 14.3**			Titanium	
6.2	**Plate Gasket**			Nitrile Rubber	

	TECHNICAL SPECIFICATION FOR		**Technical**	**PE-TS-421-179-N001 (Rev 0)**
	PLATE HEAT EXCHANGER		**Section**	**IB**
	DATASHEET - A		**Rev**	**0**
			Date	**06/01/2018**

	PROJECT		**2 x 660 MW MAITREE BANGLADESH STPP**
6.3	**Compression/Fixed/Frame/Movable Pressure plates**		Carbon Steel, ASTM A36, Epoxy painted (with Titanium cladding on ports on ACW side)
6.4	**Guide Rails/ bar**		Carbon Steel, ASTM A36 with SS cladding (CS to be epoxy painted)
6.5	**Support Beam/ column**		Carbon Steel, ASTM A36 Epoxy Coated
6.6	**Nozzle (Reducer/Expander)**		DMCW Side: Carbon steel ASTM A36, Epoxy Coated ACW Side: DUPLEX SS
6.7	**Nozzle flanges**		DMCW Side: Carbon steel ASTM A36, Epoxy Coated ACW Side: DUPLEX SS
6.8	**Flange/ Counter flanges**		DMCW Side: Carbon steel ASTM A36, Epoxy Coated ACW Side: DUPLEX SS (Connecting pipe side Counter Flanges on secondry side(ACW side) in BHEL scope, however nuts, bolts, gaskets shall be in bidder scope)
6.9	**Tightening Bolts/Rods & Nuts**		SAE 1045
6.10	**Nozzle flange bolt and nut**		SA 193 B7/ SA 194 2H
6.11	**Nozzle flange gasket**		3mm wire inserted Red Rubber
6.12	**Name Plate**		SS- AISI-316L
6.13	**Painting**		
	External Surface		
	a.) Surface Preparation		All surface other than stainless steels shall be painted. The steel surface to be applied with painting shall be thoroughly cleaned before applying painting by shotblasting (SA 2.5) etc shall be subjected to BHEL/Customer approval. For all the steel surfaces inside the (indoor installation) building, two coats of epoxy polymide resin based red oxide-zinc phosphate (primer) of minimum thickness of 30 microns/coat followed up with one coat of epoxy resin based paint with MIO/coal tar based epoxy paint of minimum thickness of 80 microns shall be applied. The top coat shall consist of two coats of epoxy polyamide enamel suitably pigmented of minimum thickness of 30 microns/coat. Thus total thickness shall be minimum 200 microns.
	b.) Primer		
	c.) Final Paint		
7.0	**Extra Carrying capacity to be provided on frame assembly.**	%	25
8.0	**Mandatory Spares**		
8.01	**Gaskets**		20% of each type and class
8.02	**Fastners**		20% of each type and class
8.03	**Plates**		20% of each type and class
8.04	**Gaskets**		1 Lot comprising 30% of total requirement of each type & size
8.05	**Fastners**		1 Lot comprising 10% each type
8.06	**Plates**		10% plates for one PHE
9.0	**Available space (L x W x H)**	mm	---------- Bidder to indicate ----------
10.0	**Weight of Assembly**	Kg	---------- Bidder to indicate ----------
11.0	**Performance Guarantee (PG testing) Demonstration at site**		PG test to be demonstrated at site by vendor for all PHEs
12.0	**Hydrotesting at Shop**		
12.1	**Hydrotesting Pressure**	Kg/cm2 (g)	1.5 times the design pressure
12.2	**Duration of Hydrotesting**	Minutes	30
13.0	**Performance curves and figures to be furnished during contact stage**		
13.1	Primary side water outlet temperature vs. Secondary side water inlet temperature.		
13.2	Primary side water flow (80% to 115%) vs. Pressure drop and outlet temperature (Secondary side flow – 100%)		
13.3	Secondary side water flow (80% to 115%) vs. Secondary side pressure drop and primary side outlet temp (Primary side flow – 100%)		
13.4	Primary side water outlet temperature vs. Primary side inlet temp.		
13.5	Film heat transfer coefficient curve		
13.6	Correction Curves.		
14.0	**Minimum Standard requirement of the PHE to be offered by the bidder.**		
14.1	Minimum Corrosion allowance on thickness (as per ASME Sec. VIII Div. I) Minimum corrosion allowance for heat exchanger parts of carbon steel material shall be 1.6 mm.		
14.2	Metallurgy specified above is bare minimum . Equivalent or Superior materials suitable for fluid handled is also acceptable subject to Customer/BHEL approval.		
14.3	Plate thickness should be adequate to withstand all operating conditions but not less than Minimum plate thickness of 0.5 mm (No negative tolerance allowed in thickness specified). The plates shall be pressed from one single piece with the corrugation being smooth, uniform and identical for every plate.		

14.4	Heat transfer plates shall be sealed at their outer edges and around the ports by gaskets in order to prevent leakage and inter-mixing of fluids.
14.5	Double sealing arrangement shall be provided at outer edge and around ports with the inter space between the seals vented to atmosphere in order to avoid inter-mixing of liquids in case of gaskets failure.
14.6	Each Plate shall be numbered in sequence with the number marked by indelible ink on each plate to permit easy reassembly.
14.7	Flanges shall be as per ANSI B 16.5 or equivalent. Thickness of pressure and frame plates shall be as per ASME Sect. VIII div.1.
14.8	Frame of exchanger should be designed so that 25% additional plates can be added in future i.e 25% extra capacity for additional plates shall be provided in frame.

DM WATER ANALYSIS

Applicable for ALL Projects (PHE - Primary Side)

ANNEXURE - A-9

CLAUSE NO.	PROJECT INFORMATION NTPC

ANALYSIS OF DM WATER TO BE USED

AS

PRIMARY FLUID FOR PHEs OF ALL THE PROJECTS

S.No.	Characteristics		Value
i)	Silica (Max.)	-	0.02 ppm as SiO2
ii)	Iron as Fe	-	Nil
iii)	Total hardness	-	Nil
iv)	pH value	-	CORRECTED TO 8.5-9.5
v)	Conductivity excludingthe effects of free CO_2	-	Not more than. 0.1

SECONDRY SIDE
COOLING WATER ANALYSIS

(SEA WATER)

SL	Sampling Location	pH Values	Temperature (^{0}C)	NTU	EC µs/cm	Alkalinity mg/L	p-alkalinity mg/L	m-alkalinity mg/L	Total hardness (mg/l)	TDS (mg/L)	Salinity (ppt)	TSS (mg/L)	DO (mg/l)	PO4 (mg/L)	Cl- (mg/L)	F- (mg/L)	NH4 (mg/L)	NO3 (mg/L)	NO2 (mg/L)	SO4 (mg/L)	BOD_5 (mg/L)	COD (mg/L)
1	High tide, Passur River, Mongla, Khulna	8,1	26,9	579	353	131	0	133		170		123		0,89	51	<.10	0,30	0,78	<.016	12	12	32
2	Low tide, Passur River, Mongla, Khulna	8,1	26,7	594	409	133	0	135		197		147		1,1	66	0,10	<.10	0,83	<.016	15	18	48
	Sampling 16 August 2014																					
3	Sampling April	7,9	31						2550	13190	12,00	54	5,7	2,1				1,3		1360	3,20	376
4	Sampling July	7,1	33						175	445	2,20	90	6,8	0,45				0,76		45	3,10	28
5	Sampling October	8,1	31								0,00		7,6								4,00	
															9724							
6	Sampling 23. May 2014: Jetty Side Passur River			77		138																

SL	Sampling Location	Al (mg/L)	Ba (mg/L)	Ca (mg/L)	Fe (mg/L)	Mn (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	FC (CFU)	TC (CFU)	SiO2 (mg/L)	P (mg/L)	TOC (mg/L)	DOC (mg/L)	Oil and Grease (mgl)
1	High tide, Passur River, Mongla, Khulna	0,85	0,107	26,75	2,0	<.05	8,7	3,9	29,11	240	460	11,7	1,2	6,25	3,93	
2	Low tide, Passur River, Mongla, Khulna	0,962	0,165	26,94	4,2	<.05	9,4	6,68	41,77	270	520	13,6	2,3	7,91	4,49	
	Sampling 16 August 2014															
3	Sampling April															< 5
4	Sampling July															< 5
5	Sampling October															
6	Sampling 23. May 2014: Jetty Side Passur River			296	0,51		737	204	8505			14,3				

3 - 5: Sampling location: Left bank of Passur River at Project Site - Jetty

SECONDRY SIDE
COOLING WATER ANALYSIS
(SEA WATER)

Consultancy Research and Testing Services (CRTS)
Department of Civil Engineering, Khulna University of Engineering & Technology

Test Results on Water Quality and Sedimentation Characteristics of Possur River at Intake Point (BIFPCL, Rampal)

Date	High Tide							Low Tide						
	Time	pH	Tur (NTU)	Elec Con (EC) mS/cm	Sedimentation (ml/L)			Time	pH	Tur (NTU)	Elec Con (EC) mS/cm	Sedimentation (ml/L)		
					30min	60min	120min					30min	60min	120min
17.01.15	1100	7.87	103	5.40	-	-	-	1730	7.78	63.5	5.25	-	-	-
18.01.15	1150	8.03	170	3.28	0.05	0.20	0.35	1830	8.03	49.5	1.80	Nil	Nil	Nil
19.01.15	1245	7.86	315	5.24	-	-	-	750	7.90	323	4.88	-	-	-
20.01.15	1330	7.90	178	5.38	0.10	0.25	0.35	830	7.90	208	4.53	0.15	0.35	0.50
21.01.15	1400	7.84	382	5.64	-	-	-	900	7.90	172	5.00	-	-	-
22.01.15	1450	7.86	337	5.50	0.45	0.60	0.70	940	7.84	239	4.94	0.15	0.25	0.40
23.01.15	1540	7.84	202	5.19	-	-	-	1020	7.84	108	5.14	-	-	-
24.01.15	1630	7.62	504	5.96	-	-	-	1050	7.41	92.7	6.24	-	-	-
25.01.15	1715	7.73	311	5.90	-	-	-	1130	7.78	144	5.85	-	-	-
26.01.15	1810	7.85	633	5.77	-	-	-	1210	7.82	299	5.49	-	-	-
27.01.15	1820	7.81	289	5.35	0.05	1.50	2.00	1300	7.85	635	5.66	1.50	3.50	5.00
28.01.15	720	7.86	332	5.47	-	-	-	1320	7.81	653	5.64	-	-	-
29.01.15	830	7.87	386	5.80	-	-	-	1500	7.86	101	5.67	-	-	-
30.01.15	1000	7.90	360	5.73	-	-	-	1630	7.89	258	11.44	-	-	-
31.01.15	1110	7.94	400	11.54	-	-	-	1745	7.97	132	9.22	-	-	-

SEA WATER

WATER ANALYSIS

A water analysis from the area adjacent to the site giving salinity and water quality is shown below:

location	Date	Temp.	pH	EC	Cl	T. Alkalinity	Turbidity	T S	TDS	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	7-Jan	27.4	7.74	3010	879	36	68.7	1565	1510	55	5.1	0.8	55	1.6
2	7-Jan	27.1	7.72	3020	878.8	36	68.5	1570	1510	60	5.1	0.8	55	1.6
3	7-Jan	27.8	7.71	3030	879	36	68.8	1565	1510	55	5.1	0.8	55	1.6
1	11-Feb	29.8	7.66	4380	1262	36	182	2390	2180	210	4.7	1	76	2.3
2	11-Feb	29.2	7.63	4380	1268	36	178	2390	2190	200	4.7	1	76	2.3
3	11-Feb	29.1	7.65	4380	1263	36	179	2380	2180	200	4.7	1	76	2.3
1	9-Mar	32.6	7.56	11780	2944.4	38	176	6080	5890	190	4.7	1.2	76	6.7
2	9-Mar	32.6	7.57	11780	2945.2	38	178	6080	5890	190	4.7	1.2	76	6.7
3	9-Mar	32.1	7.55	11780	2946.4	38	177	6090	5890	200	4.7	1.2	76	6.7
1	17-Apr	32.6	7.59	25300	8275	36	185.6	12950	12700	250	4.6	0.7	136	15.5
2	17-Apr	32.6	7.59	25300	8273	36	186.2	12950	12700	250	4.6	0.7	138	15.5
3	17-Apr	32.6	7.59	25300	8273	36	184.8	12950	12700	250	4.6	0.7	136	15.5
1	5-May	32.6	7.59	29200	9480	36	198.6	14900	14600	300	4.5	1.2	177	17.6
2	5-May	32.9	7.54	29200	9470	36	198.6	14900	14600	300	4.4	1.2	177	17.6

Figure 1 Water quality of the Passur River at Mongla point (Source: EIA-Report)

SECONDRY SIDE
COOLING WATER
ANALYSIS

SEA WATER

location	Date	Temp.	pH	EC	Cl	T. Alkalinity	Turbidity	T S	TDS	SS	DO	BOD	COD	Salinity
		°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
3	5-May	33.2	7.57	29200	9470	36	199.6	14900	14600	300	4.5	1.2	177	17.6
1	13-Jun	31.6	7.69	18000	5820	36	112.6	9200	9000	200	4.7	1.1	97	10.8
2	13-Jun	31.6	7.69	18000	5800	36	113.2	9200	9000	200	4.7	1.1	97	10.8
3	13-Jun	31.6	7.69	18000	5810	36	112.4	9200	9000	200	4.7	1.1	97	10.8
1	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
2	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
3	1-Jul	31.6	7.69	440	32.6	36	76.6	285	220	65	5.2	0.8	26	-
1	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
2	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
3	5-Aug	31.6	7.69	275	16.6	36	68.6	192	137	55	5.3	0.7	22	-
1	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
2	8-Sep	31.6	7.76	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
3	8-Sep	31.6	7.74	270	15.6	36	65.6	180	135	45	5.5	0.7	22	-
1	12-Oct	30.6	7.79	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
2	12-Oct	30.6	7.78	290	26.6	36	62.6	192	145	47	5.6	0.7	22	-
3	12-Oct	30.6	7.78	290	25.6	36	62.6	192	145	47	5.6	0.7	22	-
1	5-Nov	24.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
2	5-Nov	26.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
3	5-Nov	25.6	7.79	340	38.6	36	56.6	210	170	40	5.6	0.7	22	-
1	12-Dec	21.5	772	520	62.6	36	72.6	320	260	60	5.1	0.9	25	0.4
2	12-Dec	20.9	7.71	520	62.6	36	73.6	320	260	60	5.1	0.9	25	0.4
3	12-Dec	21.1	7.72	520	62.6	36	71.6	320	260	60	5.1	0.9	25	0.4

Figure 2 Water quality of the Passur River at Mongla point (Source: EIA-Report)

SECTION II

IIA STANDARD TECHNICAL SPECIFICATION & STANDARD QUALITY PLAN OF PHE

SECTION: IIA

PLATE HEAT EXCHANGER

STANDARD TECHNICAL SPECIFICATION

1.00.01 GENERAL

This specification covers the Design, Performance requirements, Constructional Features, Materials requirements, manufacture, assembly, Inspection and Testing at Manufacturer's and/ or his subcontractor's works and Painting requirements for delivery of Plate Heat Exchanger complete with all accessories as specified herein-after.

2.00.00 CODES AND STANDARDS:

2.01.00 The design, manufacture and testing of the plate heat exchanger complete with all accessories, shall generally conform to the latest editions of the following appropriate standards.

2.01.01 IS/BS/DIN/US Standards regarding pressure vessels, pressure piping, pipes, valves, flanges and other as necessary.

2.01.02 IS/ BS/ DIN/ ASTM for material specification and testing procedures.

2.02.00 In case of any conflict between the above codes/ standards and this specification, the latter shall prevail and in case of any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding

3.00.00 **DESIGN AND CONSTRUCTION:**

3.01.00 **General Requirements:**

3.01.01 Unless otherwise necessary, manufacture's standard and proven models of the plate heat exchanger shall be supplied.

3.01.02 The equipment shall be capable of safe, proper and continuous operation at all heat loads and water from up to those corresponding to the operating conditions mentioned in Data Sheet – A furnished a/w project enquiry. Vibration, noise, mechanical and thermal stresses shall be kept

within allowable units specified by relevant codes/ standards in design. Due attention shall be given to *case of maintenance, repair and cleaning.*

3.01.03 Suitable corrosion allowance shall be provided wherever necessary. The corrosion allowance for the heat exchanger parts such as pressure plates (support plates), nozzles, sliding channels and frame shall be 1.6 mm (minimum).

3.01.04 Each heat exchanger shall be capable of passing a flow of at least 1.1 times the design flow rate on both primary and secondary water sides. Bidder shall indicate maximum pressure drop through the heat exchanger under this condition.

3.01.05 For the purpose of calculating dirty overall heat transfer coefficient, a total fouling factor as given in Data Sheet-A furnished a/w project enquiry shall be assumed. It is expected that the cleaning frequency shall be once in a year with the above fouling factor.

3.01.06 No back wash for the heat exchangers is envisaged.

3.02.00 Performance Requirements:

3.02.01 The pressure drop across plate heat exchanger from inlet to outlet in fouled conditions for primary and secondary sides, shall not be more than those specified in Data Sheet-A furnished a/w project enquiry, for the specified flow rates.

3.02.02 For the specified flow rate and inlet temperature, the primary side (hot fluid) outlet temperature shall not be more than that specified in Data Sheet-A furnished a/w project enquiry.

3.02.03 In the event of failure to meet the above stipulated performance requirements, the equipment will be out rightly rejected.

3.03.00 **Construction of Heat Exchanger:**

3.03.01 Heat transfer plates shall be packed in a frame consisting of fixed frame plate and movable pressure plate and aligned at top and bottom of carrying bars. Design shall be such that cleaning is possible without dismantling the piping.

3.03.02 Heat transfer plates shall be sealed at their outer edges and around the ports by gaskets in order to prevent leakage and inter-mixing of fluids.

Double sealing arrangement shall be provided at outer edge and around ports. The inter space between the seals shall be vented to atmosphere in order to avoid inter-mixing of liquids in case of gaskets failure.

The gasket arrangement shall be such that it receives continuous support to ensure a long gasket life. The gasket should be able to retain their properties and shape over a life period of 10 years.

3.03.03 Heat transfer plates shall be provided with sufficient thickness in order to impart sufficient rigidity to the plates particularly from handling considerations. Plates shall have contact points in order to provide inter-plate supports. The recesses on the plates are suitably strengthened by a reinforcement plate.

Plate thickness shall be adequate to withstand all operating conditions as specified in data sheet A furnished a/w project enquiry.. Flanges shall be as per ANSI 16.5 or equivalent. Thickness of pressure and frame plates shall be as per ASME Sect. VIII div.1.25% extra capacity for additional plates shall be provided in frame.

Each Plate shall be numbered in sequence. The number shall be marked by indelible ink on the plate to permit easy reassembly. The plates shall be pressed from one piece. They shall be pressed in single/ progressive manner.

The corrugation shall be smooth, uniform and identical for every plate. The PHE bottom frame plate and support should have fixing lugs and cleats to keep provision for enabling to fit trough with outlet nozzle fitted underneath to collect and drain out water in the event of leakages.

3.03.04 Frame for each heat exchanger shall have extra capacity to accommodate the additional plates, if required in future because of any reason whatsoever. The extra capacity to be provided is indicated in Data Sheet-A furnished a/w project enquiry.

The upper carrying bar and lower guide bar shall be rigid in construction

without any risk of sagging or buckling, and shall facilitate easy guiding of the plates.

3.03.05 All inlet, outlet and other nozzles shall be flanged type and shall be as specified in Data Sheet-A. Counter flanges complete with gaskets, bolts, nuts and coatings (wherever necessary) shall be supplied for the nozzle connections. The nozzle sizes of primary/ secondary streams of PHE's shall be of adequate size within acceptable range of velocity. The size selection shall be subject to approval in the event of order.

3.03.06 If necessary, relief valves shall be provided on both the streams.

3.04.00 **Materials of construction:**

Material of the heat transfer plates and gaskets shall be consistent with the fluid handled. However, material specification for various parts shall be equal or superior to those specified in Data Sheet - A furnished a/w project enquiry.

4.00.00 **FOUNDATION AND LIFTING ARRANGEMENTS:**

4.01.00 Plate heat exchanger shall be supplied with necessary foundation plates, anchor bolts, sleeves, nuts, inserts etc.

4.02.00 Plate heat exchanger shall be equipped with suitable lifting lugs/ eyebolts to facilitate handling during erection and maintenance.

5.00.00 **PAINTING:**

5.01.00 The surface preparation of all exterior and interior surfaces of plate heat exchanger shall include the following:

a) Removal of oil, grease, dirt and swarf etc
b) Removal of rust and scale etc.,
c) Sand blasting/ shot blasting.

5.02.00 All exterior surfaces of PHE's shall be sand/ shot blasted, painted with

primer and finish coated with coal tar based epoxy coating of min. 250 microns thickness. Color shade etc. shall be subject to BHEL/ Customer approval.

6.00.00 **SHOP INSPECTION AND TESTS:**

6.01.00 **General:**

6.01.01 Manufacturer shall conduct all tests and stage inspections as per the approved quality plan to ensure that the plate heat exchanger shall conform to the requirements of this specification and of the applicable codes/ standards.

6.01.02 All materials used for manufacture/ fabrication of the plate heat exchanger components shall be of tested quality. Relevant test certificates for chemical analysis, mechanical tests and heat treatment shall be made available before the final shop inspection. In case the relevant test certificates are not available, the manufacturer shall arrange to carry out the necessary tests required as per approved quality plan and applicable codes at his cost, for which samples shall be identified by BHEL's representative.

6.01.03 All shop tests shall be conducted in the presence of BHEL's representative and test certificates for the same shall be furnished to BHEL for approval.

6.01.04 Qualification of welding procedures and welders shall be as per ASME B&PV Code, Section-IX/applicable code.

6.02.00 **Heat Transfer Plates:**

6.02.01 Plate material used for pressing shall be furnished with mill test report showing chemical and physical properties and heat treatment records. Suitable correlating mark shall be available, so that BHEL's inspector can identify the material with test certificates before pressing the plates.

6.02.02 After pressing visual and dimensional checks on the plates shall be made in the presence of BHEL's inspector, on sampling basis.

6.02.03 The heat transfer plates from each lot of the plates shall be tested by liquid/ dye penetrant test in order to check for cracks and other surface defects in presence of BHEL/customer's representative/Third party (Llyods, TUV or equivalent). If any defect is detected in any of these plates, the whole lot shall be tested and plates without defects only shall be accepted. Plate cleaning agent, liquid penetrant and developer shall not contain any halogen .Procedure for light box test and DP test shall be submitted to purchaser's approval. For Quantum of check , Refer Section C.

6.02.04 The heat transfer plates shall be tested by light box test in order to check for cracks and other surface defects in presence of BHEL/customer's representative/Third party (Lloyds', TUV or equivalent). The plates without defects only shall be accepted. For Quantum of check , Refer Section C.

6.03.00 **Gaskets:**

6.03.01 Certificate on Chemical composition of the gasket material shall be furnished to prove the quality. Sample testing in presence of BHEL's inspector shall also be conducted, if desired.

6.03.02 Shore hardness test shall be conducted on the gasket and certificate shall be furnished. Sample tests shall also be done in presence of BHEL's inspector.

6.03.03 Visual and dimensional check on a sampling basis shall be done. Plates and gaskets assembled together will be inspected for proper assembly.

6.04.00 Frame Assembly:

6.04.01 All materials for various components of frame assembly viz. frame plate, pressure plate, carrying bar, guide bar, tightening/ clamping bolts and nuts etc., shall be of tested quality and test certificates for chemical composition and physical properties shall be furnished.

6.04.02 If the thickness of the plates used for frame and pressure plates is 40 mm or more the same shall be checked ultrasonically to demonstrate the absence of lamination and lack of fusion etc.

6.05.00 All weld joints used for Fabrication of Heat exchangers shall be subjected to suitable non destructive examination. This shall include 100 % magnetic particle examination or other suitable NDT of all welds.

7.00.00 **Document submission:**

7.01.00 The tenderer shall submit during contract stage a curve showing expected DM Water (Primary side) temperature at heat exchanger outlet for each one degree centigrade variation in ACW (Secondary side) temperature, all other parameters remaining unchanged. Similar curve for expected DM Water outlet temperature for variation of ACW flow rate with ACW inlet temperature remaining unaltered shall also be furnished. The bidder shall also furnish various curves to enable, apply corrections during site PG testing in the event of any data variation from the stipulated design parameters.

7.02.00 Bidder shall also furnish thermal design calculations at contract stage to justify the no. of plates offered.

STANDARD QUALITY PLAN SHEET 1 OF 5	CUSTOMER: PROJECT TITLE: BIDDER/VENDOR: QUALITY PLAN NO.: SYSTEM: ITEM: PHE	SPECIFICATION NO. : PE-TS-XXX-179-N001 SPECIFICATION TITLE : TECHNICAL SPEICIFICATION FOR PLATE HEAT EXCHANGERS SECTION : IIA	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/ METHOD OF CHECK	EXTENT OF CHECK 2/3	EXTENT OF CHECK 1	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.
1.0	**RAW MATERIAL INSPESTION**													
1.1	Frame Plates & Pressure Plates, Counter Flanges, Connection Lining Material.Top And Bottom Carrying Bar.	Physical Properties	MA	Physical Test	1/ Heat/He-at Batch	1/ Heat/He-at Batch	App. Drg / Data Sheet	Relevant material spec.	Mill TC Or Lab Test Report	√	2,3	-	1	If co-related mill TCS are not available then check testing carried out by reputed lab
		Chemical Properties	MA	Chemical Analysis	1/ Heat/He-at Batch	1/ Heat/He-at Batch	-do-	-do-	-do-	√	2,3	-	1	-do-
		Dimensions	MA	Measurement	100%	100%	Approved Drawings		Inspection Reports	√	2,3	-	1	
		Workmanship And Finish	MA	Visual	100%	100%	-do-	-do-	-do-		2,3	-	1	
		Lamination (Applicable For Frame And Pressure Plate Only)	CR	Ultrasonic Test	100%	100%	SA 435	SA 435	-do-	√	2,3	-	1	Applicable for plate thickness more than 25 mm only
1.2	Heat Transfer Plates/Coils	Physical Properties	MA	Physical Test	1/ Heat	1/ Heat	App. Drg. / Data Sheet	App. Drg. / Data Sheet	Mill TC Or Lab Test Report	√	2,3	-	1	Co-related mill TCS to be provided. **See Remark 1**
		Chemical Properties	MA	Chemical Analysis	1/ Heat	1/ Heat	-do-	-do-	-do-	√	2,3	-	1	-do-
		Dimensions	MA	Measurement	100%	Sample	Approved Drawings		Inspection Reports	√	2,3	-	1	
1.3	Gaskets	Dimensions	MA	Measurement	100%	Sample	Approved Drawings		Inspection Reports		2,3	-	1	Co-related mill TCS to be provided.
		Workmanship And Finish	MA	Visual	-do-	-do-	No damage, No Surface defects.		-do-		2,3	-	1	
		Contour	MA	Visual	-do-	-do-	Mfg. Drgs / specification		-do-		2,3	-	1	
		Hardness	CR	Measurement	-do-	-do-	Approved Drawings		-do-	√	2,3	-	1	

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **1:** BHEL **1* SHALL BE CLEARED BY BHEL 2:** VENDOR, **3**: SUB VENDOR **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE **CHP:** CUSTOMER SHALL IDENTIFY IN COLUM "N" AS ' W"	**Cust. Logo** **FOR CUST. USE**	**DOC. NO.:** **REV.** **CAT-.**
MANUFACTURER/ SUB-SUPPLIER	**MAIN-SUPPLIER**			
SIGNATURE			**REVIEWED BY**	**APPROVED BY** / **APPROVAL SEAL**

	STANDARD QUALITY PLAN SHEET 2 OF 5	CUSTOMER: PROJECT TITLE: BIDDER/VENDOR: QUALITY PLAN NO.: SYSTEM: ITEM: PHE	SPECIFICATION NO. : PE-TS-XXX-179-N001 SPECIFICATION TITLE : TECHNICAL SPEICIFICATION FOR PLATE HEAT EXCHANGERS SECTION : IIA

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/ METHOD OF CHECK	EXTENT OF CHECK 2/3	EXTENT OF CHECK 1	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.
1.4	Tightening Bolts & Nuts. (Tie Rod)	Physical Properties	MA	Physical Test	1/ Heat	1/ Heat	App. Drg / data sheet	Relevant Material Spec.	Mill Tc Or Lab Test Report	√	2,3	-	1	Manufacturer test certificate will be submitted for review.
		Chemical Properties	MA	Chemical Analysis	1/ Heat	1/ Heat	-do-	-do-	-do-	√	2,3	-	1	-do-
		Dimensions	MA	Measurement	100%	100%	Approved Drawings		IR	√	2,3	-	1	
		Workmanship and Finish	MA	Visual	100%	100%	-do-	-do-	-do-		2,3	-	1	
		Internal Soundness (For diameter >= 40 mm)	CR	UT	100%	100%	ASTM A 388	See Remark - 3	-do-	√	2,3	-	1	UT will be carried on raw material stage.
2.0	**IN PROCESS INSPECTION**													
2.1	HT PLATES	Area Measurement	MA	White Light Scanning	1 per Type	1 per Type	Approved drawing/ data sheet	Approved drawing/ data sheet	IR	√	2,3	1	-	**See Remark 2**
		Physical Properties	MA	Physical Test	1 Sample per Heat	1 Sample per Heat	Approved drawing/ data sheet	Relevant Material Spec.	Mill TC or Lab Test Report	√	2,3	-	1	Manufacturing test certificates will be submitted for review.
		Chemical Properties	MA	Chemical Analysis	1 Sample per Heat	1 Sample per Heat	Approved/ drawing/ data sheet	Relevant Material Spec.	Mill TC or Lab Test Report	√	2,3	-	1	Manufacturing test certificates will be submitted for review.
		Dimension	MA	Measurement	1 Sample per Heat	1 Sample per Heat	Approved drawing/ data sheet	Approved drawing/ data sheet	Inspection Report	√	2,3	-	1	
		Workmanship And Finish	MA	Visual	100%	100%	Approved drawing/ data sheet	No scratches, cracks etc.	-do-		2,3	-	1	

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER
SIGNATURE	

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **1:** BHEL **1* SHALL BE CLEARED BY BHEL 2:** VENDOR, **3**: SUB VENDOR
P: PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE
CHP: CUSTOMER SHALL IDENTIFY IN COLUM "N" AS ' W"

Cust. Logo

FOR CUST. USE

DOC. NO.:		REV. CAT-.
REVIEWED BY	APPROVED BY	APPROVAL SEAL

STANDARD QUALITY PLAN SHEET 3 OF 5	CUSTOMER: PROJECT TITLE: BIDDER/VENDOR: QUALITY PLAN NO.: SYSTEM: ITEM: PHE	SPECIFICATION NO. : PE-TS-XXX-179-N001 SPECIFICATION TITLE : TECHNICAL SPEICIFICATION FOR PLATE HEAT EXCHANGERS SECTION : IIA	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/ METHOD OF CHECK	EXTENT OF CHECK 2/3	EXTENT OF CHECK 1	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.
		Surface Defects And Cracks	CR	DP test	10%	2 % or min. 100 nos. whichever is higher	Manufacturer's DP test procedure (to be reviewed and approved by BHEL/Customer during contract stage)		DPT Report	√	2,3	1	-	**See Remark 3**
				Light Box Test/ Vacuum chamber test	100%	10%	Manufacturer's Light Box/Vacuum test procedure (to be reviewed and approved by BHEL/Customer during contract stage)		Vacuum Test Report	√	2,3	1	-	**See Remark 3**
		PMI testing	CR	PMI test	100 %	1 Sample per Heat	Approved drawing/ data sheet		PMI Compliance report	√	2,3	-	1	**See Remark 5**
2.2	Welding Procedures Specification (WPS)	Correctness	MA	Verification	100%	100%	ASME SEC-IX.	ASME SEC-IX.	QW 482 ASME SEC-IX	√	2,3	-	1	Customer /BHEL/ TPI (NPCIL, EIL, LLYODS & BVIS) approved WPS shall be used for welding
2.3	Procedure Qualification Records (PQR)	Suitability	MA	Visual & Mechanical Test	100%	100%	-do-	-do-	QW 483 ASME SEC-IX.	√	2,3	-	1	
2.4	Welders Performance Qualification	Welder's Performance Soundness Of Welds	MA	Visual / RT & Mechanical	100%	100%	-do-	-do-	QW 484 ASME SEC-IX	√	2,3	-	1	Only customer / BHEL/ TPI (NPCIL, EIL, LLYODS & BVIS) approved welder shall be engaged for welding.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **1:** BHEL **1* SHALL BE CLEARED BY BHEL 2:** VENDOR, **3**: SUB VENDOR **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE **CHP:** CUSTOMER SHALL IDENTIFY IN COLUM "N" AS ' W"	**Cust. Logo**	DOC. NO.: REV. CAT-.
MANUFACTURER/ SUB-SUPPLIER	**MAIN-SUPPLIER**		**FOR CUST. USE**	
SIGNATURE				**REVIEWED BY** / **APPROVED BY** / **APPROVAL SEAL**

STANDARD QUALITY PLAN SHEET 4 OF 5	CUSTOMER: PROJECT TITLE: BIDDER/VENDOR: QUALITY PLAN NO.: SYSTEM: ITEM: PHE	SPECIFICATION NO. : PE-TS-XXX-179-N001 SPECIFICATION TITLE : TECHNICAL SPEICIFICATION FOR PLATE HEAT EXCHANGERS SECTION : IIA	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/ METHOD OF CHECK	EXTENT OF CHECK 2/3	EXTENT OF CHECK 1	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.		** 10.			11.
2.5	Weld joint of expander/reducer.	Welding Of Outer Flange To Reducer/Expander	MA	Visual	100%	100%	Approved Drawings		Inspection Report	√	2,3	-	1	
				DPT	100%	100%	Manufacturer's DP test procedure (to be reviewed and approved by BHEL/Customer during contract stage)		DPT Report	√	2,3	1	-	
2.6	PHE Structure	Workmanship and finish	MA	Measurement & Visual	100%	100%	Approved Drawings		Inspection Report	√	-	2	1	
2.7	Plate Gaskets	Presence Of Gasket	MA	Visual	100%	100%	Mfg. Spec.	Mfg. Spec.	-do-	√	2	1	-	
2.8	Plate arrangement to flow diagram	Correctness	CR	Visual as per flow diagram	100%	100%	Approved Drawing		Inspection Report		2	-	1	
2.9	Assembly of tightening bolts and nuts	Squeezing of threads on T/B	MA	Visual	100%	100%	Approved Drawing / Data sheet		-do-		2	-	1	
2.10	Plate Pack	Length	MA	Dimension Measurement	100%	100%	Approved Drawing		-do-		2	-	1	
3.0	**FINAL INSPESTION**													
3.1	Complete Assembly	a. Conformance to GA drg.	MA	-do-	100%	100%	-do-	-do-	-do-		2	1	-	CHP
		B. Dimensions, No. of Heat Transfer Plates, Workmanship & finish	MA	-do-	100%	100%	-do-	-do-	-do-	√	2	1	-	CHP
3.2	Unbalanced hydrostatic pressure (Primary Side)	Leakage / strength of structure	MA	Hyd. Test	100%	100%	Manufacturer's Hydro test procedure (to be reviewed and approved by BHEL/Customer during contract stage)		Hydro Test Report	√	2	1	-	CHP; Hydro test @ 1.5 times the design pressure with 60 minutes holding time.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **1:** BHEL **1* SHALL BE CLEARED BY BHEL 2:** VENDOR, **3**: SUB VENDOR **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE **CHP:** CUSTOMER SHALL IDENTIFY IN COLUM "N" AS ' W"	**Cust. Logo**	DOC. NO.: REV. CAT-.
SIGNATURE			**FOR CUST. USE**	REVIEWED BY / APPROVED BY / APPROVAL SEAL

STANDARD QUALITY PLAN SHEET 5 OF 5	CUSTOMER: PROJECT TITLE: BIDDER/VENDOR: QUALITY PLAN NO.: SYSTEM: ITEM: PHE	SPECIFICATION NO. : PE-TS-XXX-179-N001 SPECIFICATION TITLE : TECHNICAL SPEICIFICATION FOR PLATE HEAT EXCHANGERS SECTION : IIA	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CAT	TYPE/ METHOD OF CHECK	EXTENT OF CHECK 2/3	EXTENT OF CHECK 1	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.
3.3	Unbalanced hydrostatic pressure (Secondary Side)	Leakage / strength of structure	MA	Hyd. Test	100%	100%	-do-	-do-	√		2	1	-	CHP; Hydro test @ 1.5 times the design pressure with 60 minutes holding time.
3.4	Completeness of all previous tests	Completeness	MA	Verification of reports	100%	100%	Tech. Specs / App. Drawings	Completion Certificate	√		2	-	1	
3.5	Painting	Dry film thickness & shade	MA	Measurement & visual	100%	100%	Customer/BHEL Tech. Spec. / Approved Data sheets	-do-	√		2	-	1	
3.6	Packing	Completeness	MA	Measurement & visual	100%	100%	Customer/BHEL Tech. Spec. / Approved Data sheets	-do-	√		2	-	1	Packing procedure as per Annexure B.

REMARKS:-

1. Original Mill TC's to be furnished by vendor to BHEL representative during inspection stage. BHEL to verify physical correlation of Mill TC's with material.
2. Inspection of Heat Transfer Plate Area Measurement shall be by White Light Scanning Method from BHEL(Refer Annexure –A). In case, inspection of plate area measurement by white light scanning method of specific PHE model has been witnessed by BHEL in past project then Type test certificates are acceptable to BHEL for same.
3. Reg. Dye Penetrant Test & Light Box Test: There shall be random witness by BHEL/ NTPC at Bidder's works, in case any defect is found in any of selected % of plates, the whole lot shell be tested in presence of BHEL & Customer. H.T. Plates without defect only shall only be accepted.
4. Ultrasonic test of tie rods shall be carried out using 10 mm / 20 mm size Normal Beam Probe of frequency 2 MHz. Using this probe the back wall echo in the sound area of bar shall be adjusted to 100% of full Screen Height (FSH). The whole bar shall be scanned under this sensitivity setting. In this sensitivity setting any defect echo indication having height greater than 20% of FSH is not acceptable.
5. 100% PMI Inspection for material grade of PHE Heat Transfer plates shall be from third party like TUV/Lloyd & certificate shall be submitted for review of BHEL. BHEL reserves the right to conduct random & independent PMI inspection on PHE's Heat Transfer plates to ascertain the plate material.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **1:** BHEL **1* SHALL BE CLEARED BY BHEL 2:** VENDOR, **3**: SUB VENDOR **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE **CHP:** CUSTOMER SHALL IDENTIFY IN COLUM "N" AS ' W"	**Cust. Logo**	**DOC. NO.:**	**REV.**	**CAT-.**
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SIGNATURE				**REVIEWED BY**	**APPROVED BY**	**APPROVAL SEAL**

Annexure-A to Standard Quality Plan

PROCEDURE FOR MEASUREMENT OF HEAT TRANSFER SURFACE AREA OF THE PHE PLATES

Definition of Heat transfer area:-

The Heat transfer area of the PHE plate is the area of the plate participating in the heat transfer process viz. the wetted surface area inside the gasketed groove of the plate as shown in the **Annexure 1**.

Steps to Measure the Heat transfer Area:

1) The surface area of the plate shall be cleaned thoroughly.
2) Apply the developer (as used in Dye Penetrant test) over the entire surface area of the plate.
3) Fix the reference stickers at several appropriate locations on the plate.
4) White light (CFL) is projected on the plate.
5) The entire surface area including all the geometrical features of the plate (corrugations) is captured by the 3D camera.
6) The 3D image of the plate is then converted into CAD format.
7) The surface area can be measured from the 3D· CAD drawing.

ANNEXURE-1

Heat transfer area to be measured-Shown in Hatched portion below

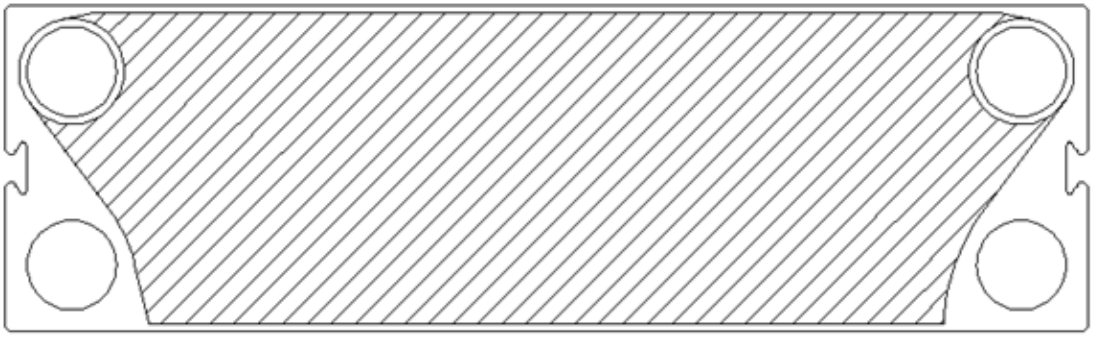

Fig. 1: Wetted Surface Area for Parallel Connection

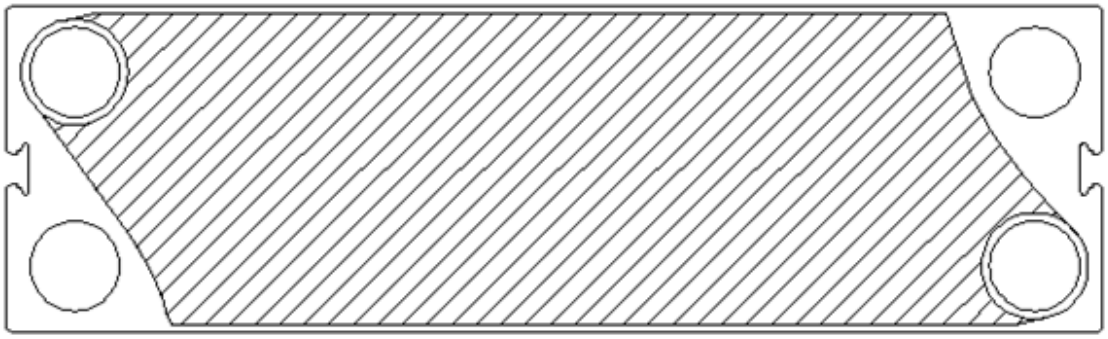

Fig. 2: Wetted Surface Area for Diagonal Connection

Annexure-B to Standard Quality Plan

PHE packing procedure before dispatch

1. Purpose:

The purpose of this procedure is to outline the requirements and procedures for protecting the equipment's during shipment and preserving during the storage.

2. Preparation for Packing:

- After hydro testing, operation, all fluids e.g. water etc., shall be completely drained from all PHE's, and the equipment blown dry.
- All material shall be cleaned internally and externally to remove, scale, rust fillings and any other foreign material.
- The PHE shall be placed on a strong wooden base & bolted to the wooden base using the foundation holes for further transportation upto site.

3. Protection of parts:

- Plate Heat Exchangers shall be packed in proper sizes of wooden cases. High grade woods like Rubber woods, jungle wood, hard wood, mango wood, pine wood, etc. is used for packing.
- All finished (or) machined (External C.S. Surfaces shall be protected against corrosion with corrosion resisting coating, which is easily removable (Compound shall be such that it will remain on the surface at temperature normally encountered during shipping & storage).
- All machined surfaces shall be protected from mechanical damage. All external unfinished carbon steel surfaces shall be sand blasted & shall be coated with rust preventive primer.
- Flanged opening if any shall be covered with blank flanges sealed with blank gasket of natural rubber or equivalent. Butt welded opening shall be closed with temporary closing covers. Internal threads shall be protected with metal plug sealed with Teflon tape (if applicable). External thread shall be protected with PVC sleeve.
- Wooden cases shall be covered with HDPE cloth from inside wooden box and the top. All the opening in plate heat exchanger shall be closed properly by suitably covering to prevent foreign material entering in plate heat exchanger.
- Loose material, primary and secondary a shall be packed in corrugated box and plastic bags with proper tagging.
- All fabricated wooden cases & crates conform to the requirement as per table given below:

Gross Weight [Kgs.]	Board Thickness	Batton / Rafter Thickness
2000 to 9000	Min. 30 mm	Min. 35 mm

9000 to 18000	Min. 50 mm	Min. 35 mm

- All the equipment shall be protected for entire period of dispatch, storage and erection against corrosion, incidental damage due to vermin, sunlight, rain, high temperature, humid atmosphere, rough handling in transit and storage. All MS parts which are not painted shall be provided with coating of grease.
- Clay Desiccant or such other moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.

4. Special tools and Spare parts:

Special tools and tackles and spares shall be packed separately with adequate identification. Such packages shall be identified as Tools/Commissioning/Operational spares.

5. Preservation

The equipment's shall be stored under closed/open space in packed condition until installation. The packages containing loose plates and gaskets are to be protected from extreme climatic conditions.

6. **Sea-worthy packing** is applicable for Complete PHE package. Details of Sea-worthy packing is enclosed with NIT.

SECTION III

IIIA COMPLIANCE CERTIFICATE (TO BE SUBMITTED BY BIDDER DURING TENDER STAGE).

IIIB GUARANTEE SCHDULE (TO BE SUBMITTED BY BIDDER DURING TENDER STAGE).

IIIC DATASHEET –B FORMAT (TO BE SUBMITTED BY SUCESSFUL BIDDER AFTER AWARD OF CONTRACT).

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer

a.) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.

b.) QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.
The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.

c.) All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval.
GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.

d.) There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'

e.) The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.

f.) The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).

g.) All sub vendors shall be subject to BHEL/CUSTOMER approval.

h.) Any special tools & tackles, if required, shall be in bidder's scope.

i.) Performance Guarantees for PHE's shall stand valid as per commercial terms and conditions.

j.) Regarding bidder's association with their respective Principals (Plate & Gasket supplier) bidder confirms the following:

i. Plate supplier shall vet the thermal design of PHE at tender and contract stage and certify the adequacy of design and no of plates.
ii. Guarantee schedule duly vetted by Principal shall be submitted during contract stage.
iii. Bidders have back to back arrangement with their principal for technical guarantees.

	SCHEDULE OF PERFORMANCE GUARANTEES		SPECIFICATION NO.	PE-TS-421-179-N001
			Section	IIIB
	PLATE HEAT EXCHANGER-SG		Rev No.	0
SL. NO.	**DESCRIPTION**	**UNIT**	**GUARANTEE VALUE**	
			2X660 MW MAITREE BANGLADESH STPP PHE for TG & Station Aux.	**2X660 MW MAITREE BANGLADESH STPP PHE for SG Aux.**
1.0	**PRIMARY SIDE (HOT WATER SIDE)**			
	CLEAN CONDITION			
a)	Flow rate	$M^3/Hr.$		
b)	DMCW inlet temperature	^oC		
c)	DMCW outlet temperature	^oC		
d)	Pressure drop	MWC		
2.0	**SECONDARY SIDE (COLD WATER SIDE)**			
	CLEAN CONDITION			
a)	Flow rate	$M^3/Hr.$		
b)	ACW inlet temperature	^oC		
c)	ACW outlet temperature	^oC		
d)	Pressure drop	MWC		
3.0	**PRIMARY SIDE (HOT WATER SIDE)**			
	FOULED CONDITION			
a)	Flow rate	$M^3/Hr.$		
b)	DMCW inlet temperature	^oC		
c)	DMCW outlet temperature	^oC		
d)	Pressure drop	MWC		
4.0	**SECONDARY SIDE (COLD WATER SIDE)**			
	FOULED CONDITION			
a)	Flow rate	$M^3/Hr.$		
b)	ACW inlet temperature	^oC		
c)	ACW outlet temperature	^oC		
d)	Pressure drop	MWC		

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE

NAME

SIGNATURE

DATE

	Title **DATA SHEET - B**	**SPECIFICATION NO.** PE-TS-XXX-179-N001
BHEL	**PLATE HEAT EXCHANGER**	SECTION **IIIC**
		SHEET 1 OF 7

INSTRUCTION TO BIDDER

1. This data sheet shall be read in conjunction with Specification No. PE-TS-XXX-179-N001 Section- IA & IB.
2. Items which deviate from Specification shall be marked with an asterisk (*)

SL.NO.	ITEM	UNIT	PARTICULARS	
1.0	**General**			
1.1	Number of plate heat exchangers being supplied.	Nos.		
1.2	Manufacturer			
1.3	Model Number/ Type			
1.4	Whether single or double pass			
1.5	Flow Pattern			
2.0	**Design**			
2.1	Design Pressure	bar (g)		
2.2	Design Temperature	^{o}C		
2.3	Heat Load(without LMTD correction)	KW		
2.4	Heat Load(with LMTD correction)	KW		
2.5	LMTD (Corrected)	^{o}C		
3.0	**Guaranteed Performance for Each Heat Exchanger**		**Primary Side (Hot Fluid)**	**Secondary Side (Cold Fluid)**
3.1	Flow rate	M^3/hr		
3.2	Inlet temperature	^{o}C		
3.3	Outlet temperature	^{o}C		
	a) In fouled conditions			
	b) In clean conditions			
3.4	Total pressure drop across heat exchanger from inlet to outlet(including inlet & outlet nozzles)	bar		
	a) For design flow			
	b) For 110% design flow rate			

Name of Bidder/ Vendor

Revision Number	0	1	2	3	4
Signature of Bidder/ Vendor Authorised Representative					
Date :					

	Title **DATA SHEET - B**	SPECIFICATION NO. PE-TS-XXX-179-N001
BHEL	**PLATE HEAT EXCHANGER**	SECTION **IIIC**
		SHEET 2 OF 7

INSTRUCTION TO BIDDER

1. This data sheet shall be read in conjunction with Specification No. PE-TS-XXX-179-N001 Section- IA & IB.
2. Items which deviate from Specification shall be marked with an asterisk (*)

SL.NO.	ITEM	UNIT	PARTICULARS	
4.0	**Heat Transfer & Fluid flow data**		**Primary Side (Hot Fluid)**	**Secondary Side (Cold Fluid)**
4.1	Film heat transfer co-efficient	KCal/hrM^2 ^{o}C		
4.2	Fouling factor	M^{2}hr ^{o}C/KCal		
4.3	Overall fouling	M^2 hr^{o}C/KCal		
4.4	Overall heat transfer coefficient	KCal/hrM^2 ^{o}C		
	a) In clean conditions			
	b) In fouled conditions			
4.5	Total effective heat transfer area per heat exchanger	M^2		
4.6	Average velocity	m/s		
	a) Through ports			
	b) Through Plate Channels			
4.7	Pressure drop in ports	bar		
	a) In Clean Condition			
	b) In fouled conditions			
4.8	Pressure drop in channels	bar		
	a) In Clean Condition			
	b) In fouled conditions			
4.9	Maximum differential pressure between hot and cold fluids in plate channels (operating)	bar (g)		

Name of Bidder/ Vendor

Revision Number	0	1	2	3	4
Signature of Bidder/ Vendor Authorised Representative					
Date :					

	Title **DATA SHEET - B**	SPECIFICATION NO. PE-TS-XXX-179-N001
BHEL	**PLATE HEAT EXCHANGER**	SECTION **IIIC**
		SHEET 3 OF 7

INSTRUCTION TO BIDDER

1. This data sheet shall be read in conjunction with Specification No. PE-TS-XXX-179-N001 Section- IA & IB.
2. Items which deviate from Specification shall be marked with an asterisk (*)

SL.NO.	ITEM	UNIT	PARTICULARS
5.0	**Heat Transfer Plates**		
5.1	Area of each plate	M^2	
5.2	Dimension (width x height)	mm x mm	
5.3	Thickness	mm	
5.4	Material & chemical composition		
5.5	Number of plates per heat exchanger	Nos.	
5.6	Maximum number of plates that can be accommodated in the heat exchanger frame	Nos.	
5.7	Type of corrugation		
5.8	Minimum plate pack length a) As per 5.5 above b) As per 5.6 above	mm	
	Maximum plate pack length a) As per 5.5 above b) As per 5.6 above	mm	
5.9	Average spacing between two plates	mm	
5.10	Hold up volume of each passage	M^3	
5.11	Port size (diameter)	mm	
6.0	**Plate Gaskets**		
6.1	Type		
6.2	Material and composition		
6.3	Thickness of gasket	mm	
6.4	Hardness of gasket		
6.5	Expected life of gasket		

Name of Bidder/ Vendor

Revision Number	0	1	2	3	4
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INSTRUCTION TO BIDDER

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SL.NO.	ITEM	UNIT	PARTICULARS
7.0	**Carrying Bar**		
7.1	Type of construction		
7.2	Number per heat exchanger		
7.3	Size		
7.4	Material		
8.0	**Guide Bar**		
8.1	Type of construction		
8.2	Number per heat exchanger		
8.3	Size		
8.4	Material		
9.0	**Frame Plate**		
9.1	Type of Construction		
9.2	Material		
10.0	**Pressure Plate**		
10.1	Type of construction		
10.2	Material		
11.0	**Supporting Columns**		
11.1	Type of Construction		
11.2	Material		
12.0	**Clamping/Gasket Compression Arrangement**		
12.1	Type of arrangement		
12.2	Tie Rod size & material (Length to take care 25% extra plates)		
12.3	Tie Rod Nuts size & material		
12.4	Nozzle flange stud size & material		
12.5	Nozzle flange Nut size & material		

Name of Bidder/ Vendor					
Revision Number	**0**	**1**	**2**	**3**	**4**
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INSTRUCTION TO BIDDER

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SL.NO.	ITEM	UNIT	PARTICULARS	
13.0	**Inlet & outlet Connection Nozzles**		**Primary Side (Hot Fluid)**	**Secondary Side (Cold Fluid)**
13.1	Size	mm		
13.2	Rating			
13.3	Facing & drilling standard			
13.4	Flange material			
13.5	Are all nozzles counter-flanges, bolts, nuts, gaskets etc., are included in the offer?		YES/NO	
14.0	Recommended Cleaning frequency of the heat exchanger for assumed fouling factor	Months		
15.0	Is backwash necessary		YES/NO	
16.0	Are all auxiliaries and accessories included in the offer		YES/NO	
17.0	Are all counter-flanges with nuts, bolts and gaskets for all terminal points included in the offer?		YES/ NO	
18.0	Are all heat exchangers supplied with necessary foundation plates, anchor, bolts, sleeves, inserts, lifting lugs etc., as specified.		YES/ NO	

Name of Bidder/ Vendor

Revision Number	**0**	**1**	**2**	**3**	**4**
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INSTRUCTION TO BIDDER

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SL.NO.	ITEM	UNIT	PARTICULARS
19.0	**Shop Tests & Inspection**		
19.1	Whether all the tests and inspections as detailed in the specification/ quality plan are carried out		YES/ NO
19.2	Hydrostatic Test :		
	a) Test Pressure	bar (g)	
	b) Test duration	min.	
19.3	Are all plates checked for cracks and other defects by the penetration method?		YES/NO
	If not, what percentage is checked?		
19.4	Is hardness test conducted for plate gaskets?		YES/NO
20.0	**Details of Painting**		
20.1	***Exterior surface***		
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
20.2	***Interior Surface***		
	a) Surface preparation		
	b) Primer		
	c) Finish Preparation		
21.0	Weight of each heat exchanger	kg.	

Name of Bidder/ Vendor					
Revision Number	**0**	**1**	**2**	**3**	**4**
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Date :					

	Title **DATA SHEET - B**	**SPECIFICATION NO.** PE-TS-XXX-179-N001
BHEL	**PLATE HEAT EXCHANGER**	SECTION **IIIC**
		SHEET 7 OF 7

INSTRUCTION TO BIDDER

1. This data sheet shall be read in conjunction with Specification No. PE-TS-XXX-179-N001 Section- IA & IB.
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SL.NO.	ITEM	UNIT	PARTICULARS
	a) Empty b) Flooded		
	Flooded Weight of heat exchanger with Max. Plates		
22.0	Overall dimensions - (Length x Breadth x Height)	mm x mm x mm	
23.0	withdrawal space		
24.0	Recommended Maintenance tools and tackles furnished		Yes/No
25.0	Mesh Size of recommended Strainer	mm	
26.0	Foundation nuts and bolts supplied		Yes/No
27.0	Other information (if any)		

Name of Bidder/ Vendor

Revision Number	**0**	**1**	**2**	**3**	**4**
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